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CULTURAL AND ECONOMIC CHANGES OF BASTOS, A JAPANESE COLONY ON BRAZIL'S PAULISTA FRONTIER[1]

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OF the numerous foreign colonies which have developed on Brazil's Paulista frontier during the last forty years, perhaps none hold more interest or present a greater challenge to the student of human geography than those established by the Japanese. The problem of cultural adjustment to a markedly different physical and social environment, faced by all foreign colonists in western São Paulo, has been complicated in the case of the Japanese by at least two exceptional handicaps: (1) racially and culturally the Japanese are orientals in a society whose primary ingredients are European, with a small admixture of African and Indian;[2] (2) the identification of the colonists with prewar expansionist Japan marked them as a potential anti-national minority and strongly aroused the suspicions of the Brazilians. Probably no foreign group has found adjustment to the Brazilian scene so painful as have the Japanese.

An evaluation of Japanese colonies on the Paulista frontier, however, offers an opportunity for more than an academic study in adjustment. The success or failure of these settlements may well determine Brazil's future policy on Japanese immigration, an item of vital importance to Japan's mounting population. Equally important, since the Japanese colonies have been an integral part of the inland march of colonization in São Paulo, they present a means of viewing the rapid economic and population changes along that most volatile of settlement frontier, the Brazilian pioneer fringe.[3]

In selecting Bastos to illustrate Japanese colonization, the author had more than a case study in mind. Bastos has been one of the largest Japanese colonies in all Brazil and a primary focus of Japanese agricultural settlement in São Paulo; it is a major base from which Japanese colonists are proceeding westward to the Mato Grosso; it has supplied much of the Japanese population which currently lives in Tupã and other urban centers including Marilia and even São Paulo city. At different times in its economic history, the colony has ranked as Brazil's leading producer of cotton, silk, and eggs—products which have been Japanese specialties par excellence. Perhaps no other colony in Brazil mirrors as effectively as Bastos the adjustment problems and the patterns of change of Japanese colonization because Bastos has been not only an important nucleus of settlement in itself, but it has also supplied much of the seed stock for the expansion of Japanese settlement to other parts of the country.

[1] The author feels a warm sense of accomplishment in having obtained the aid of the Bastos Japanese for this study. Warned by Brazilians that the Japanese were suspicious of outsiders and would not cooperate, he found the reverse to be true. He is grateful to all the people at Bastos who were kind to him, but particularly to Mr. Atsushi Taniguchi who acted as interpreter and host and to Mr. Tohru Nishi. The author is also indebted to the Departamento de Imigracão e Colonizacão of São Paulo for supplying much valuable data on Bastos, and to the University of Maryland for research funds.

[2] While Brazilians have a well-deserved reputation for racial tolerance, it remains that the Japanese were a new and untried racial ingredient in their midst. More than race, however, it was the association of the colonists with imperial Japan which created prejudice.

[3] The zones of recent settlement which Brazilian geographers call the pioneer fringes are not restricted to São Paulo; they also include northern Paraná and even parts of the Mato Grosso.

LOCATION

The Bastos colony is included for the most part in a municipality of the same name located in western São Paulo state[4] (see Fig. 1). In its general setting, the area forms part of the dissected sedimentary plateau country which characterizes São Paulo between the Rio Grande in the north and the Paranapanema in the south (see Fig. 2). Rivers flowing westward to the Paraná have cut the plateau into roughly parallel ridges and valleys ("espigões e valles"), and Bastos is located in one of these valleys, that of the Rio Peixe. The colony is not directly on a railroad, but it has access by dirt roads to two lines, the Paulista Railway, which runs on the ridge to the north of the Peixe, and the Sorocabana, which follows the ridge to the south.[5] Iacri and Tupã on the Paulista and Rancharia on the Sorocabana are the principal outlets for Bastos products moving eastward. Iacri is more than 400 miles (17 hours) by rail from São Paulo City.

Despite location in the valley of the Peixe, agriculture at Bastos is beset by a number of drawbacks. The soils tend to be sandy and highly friable and have a low water-retaining

[4] Japanese settlement extends beyond the municipal limits of Bastos into adjoining "municipios," such as Tupã, Quatã, Rancharia, and Quintana. Regardless of municipal location, however, the focus of the Japanese colony is Bastos.

[5] In this part of São Paulo, railroads typically follow the ridges or interfluves instead of the valleys to avoid the cost of constructing many bridges, the danger of malaria, and other disadvantages of the lowlands.

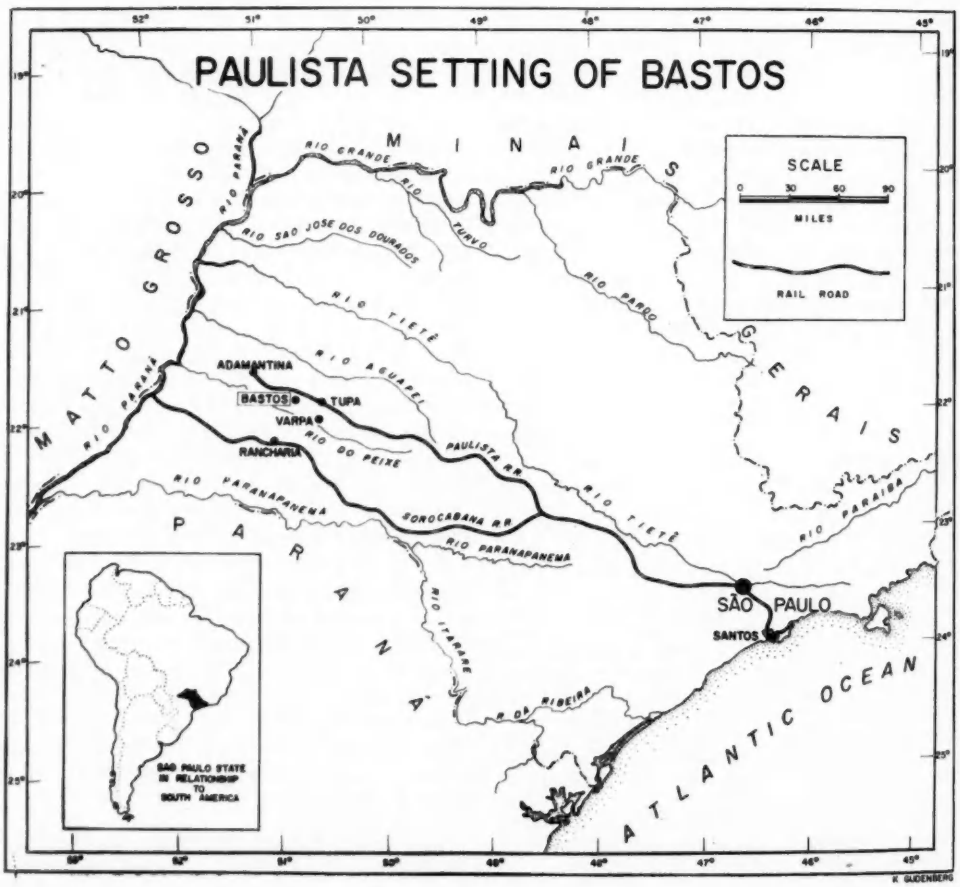

FIGURE 1

capacity; their organic content is low and crop yields from them drop sharply after only a few years of cultivation. The climate of the region is subtropical (Cwa) but frosts, while infrequent, represent a potential danger to tropical crops. The precipitation factor can also be a hindrance to crop production. Total annual rainfall amounts to approximately 47 inches, of which 20 inches fall during the rainy season from October to January. A combination of high temperature and sandy soils reduces the effectiveness of precipitation with the result that partial crop failure due to inadequate water supply is an ever-present threat. Since much of the rain falls in the form of heavy thunder showers, crop destruction by hail is an added danger.

The few patches of original vegetation which still remain indicate that the Peixe Valley was once characterized by a predominantly forest cover locally called a "*mato cerrado*." At present, little is left of this mato, however. Clearing the land for agricultural use, the sale of wood to the railroads for fuel, and the large local demands for lumber since Japanese settlement began in the late 1920's have resulted in such a rapid destruction of the forest that currently the colony faces a serious wood shortage for construction, fuel, and fence posts.

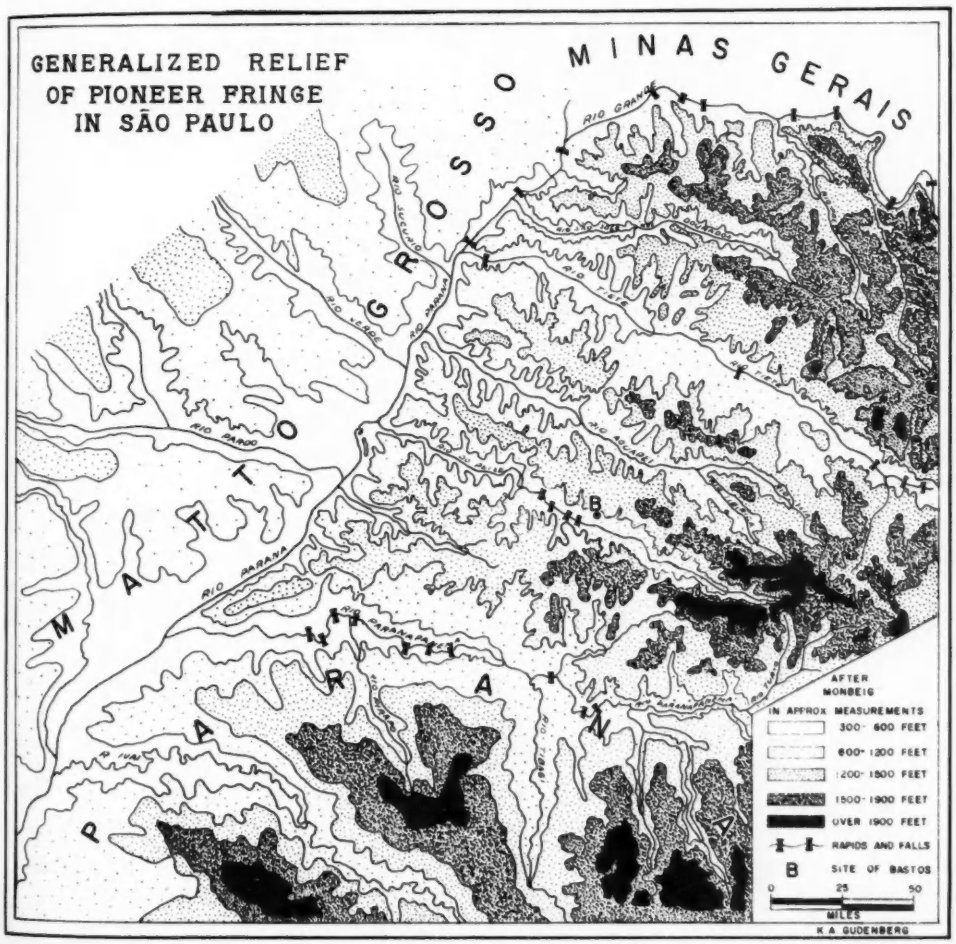

FIGURE 2

Prior to the coming of the Japanese, the Bastos area, like much of western São Paulo, was a "sertão" little touched by post-Columbian colonization. Since then it has witnessed the phenomenal development, often accompanied by rapid decline, so characteristic of the Brazilian pioneer fringe. The Paulista frontier is young country where complete transformation from mato to intense cultivation to pasture land or complete abandonment may be effected in the space of a few decades. The advance of the pioneer front gives rise to boom towns which quickly fall into stagnation or decay as settlement moves westward.[6] In the words of Monbeig, ". . . rien n'est stable, rien n'est définitif, et économie et peuplement sont solidaires de la marche pionnière qui

[6] A. Franca, "The Coffee Trail and the Pioneer Fringes," *Guide Book of Excursion 3, XVIII International Geographical Congress* (Rio de Janeiro, 1956), pp. 7–8.

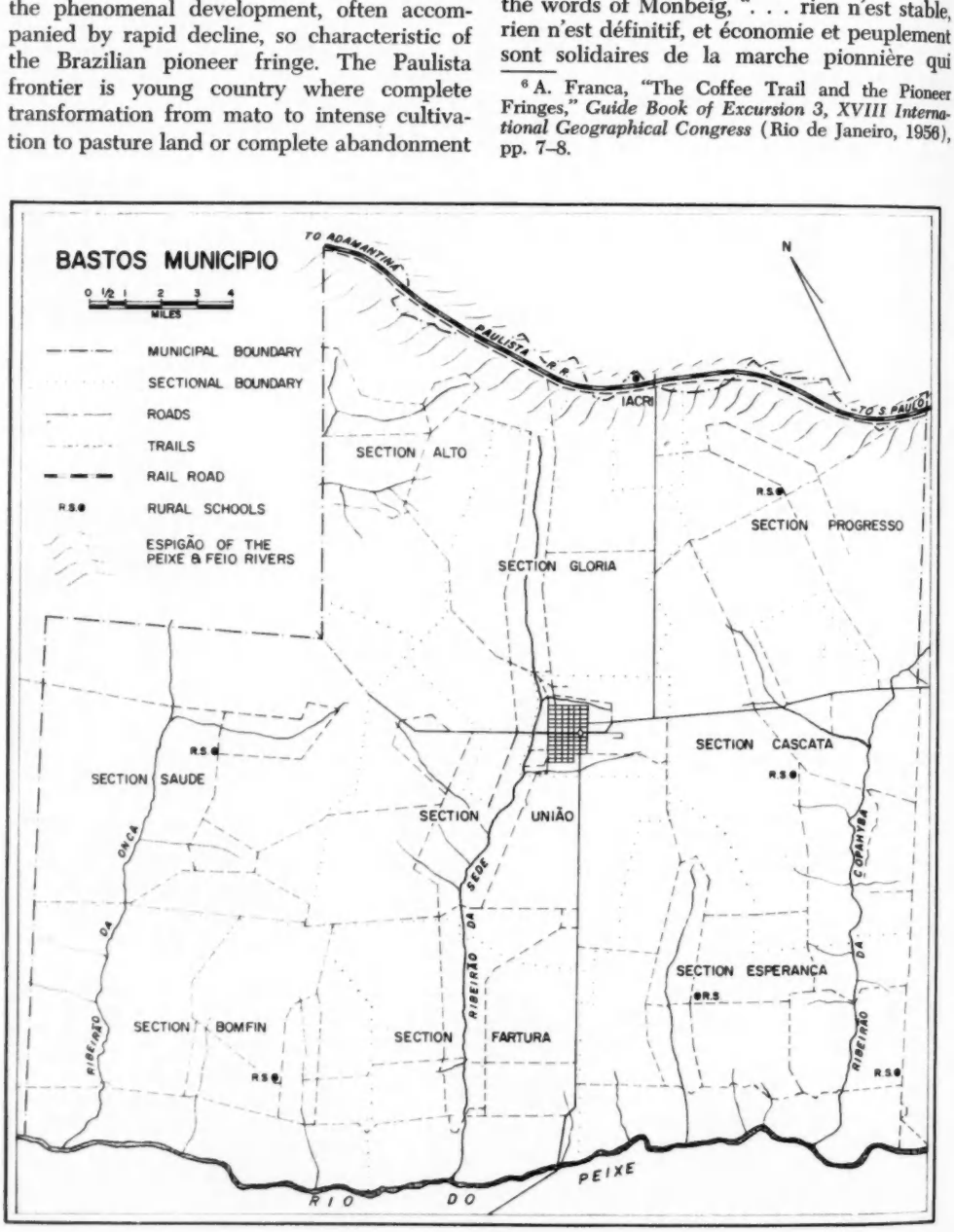

FIGURE 3

avance inexorablement vers l'Ouest. . . ."[7] It is within this dynamic medium that Japanese Bastos has evolved in the last 30 years.

IN THE BEGINNING

The Bastos colony was founded in 1927 by the Sociedade Colonizadora do Brazil Limitada as one of several Japanese settlements established west of Marilia at this time. The Sociedade was an exclusively Japanese-owned company which, prior to the war, functioned as an instrument of the imperial government under the supervision of the Japanese consulate in São Paulo. The degree of control exerted by Japan over the colonists was almost absolute. The company bought land in Brazil,[8] established a bank, and arranged for the passage of the colonists; it helped organize cooperatives, supplied farm machinery, and arranged for schools (which taught only in Japanese), hospitals, and other social services. The law of the colony was laid down by the company, and every effort was made to insulate the colonists from Brazilian influence and keep alive their patriotism for Japan.

Screening of the colonists began from the moment of recruitment. Effort was apparently made to recruit largely from among young, vigorous peasant couples who possessed some capital and whose political views were considered safe. As a result, while the original colonists included a few professionals and some artisans, the vast majority were young farmers with a starting capital which ranged from 500 to 5,000 "cruzeiros"[9] per farm family.[10] The colonists, whose number had

[7] P. Monbeig, *Pionniers et Planteurs de São Paulo* (Paris, 1952), p. 11.

[8] Brazilian authorities estimate that by 1939 the Sociedade owned 86,980 *alqueires* (over half a million acres) of land in the states of São Paulo and Paraná.

[9] In September 1957 the Brazilian cruzeiro was valued at 80 per dollar, U.S., but in 1927 its value was much higher.

[10] Data on starting capital was obtained from the Departamento de Imigracão e Colonizacão of São Paulo.

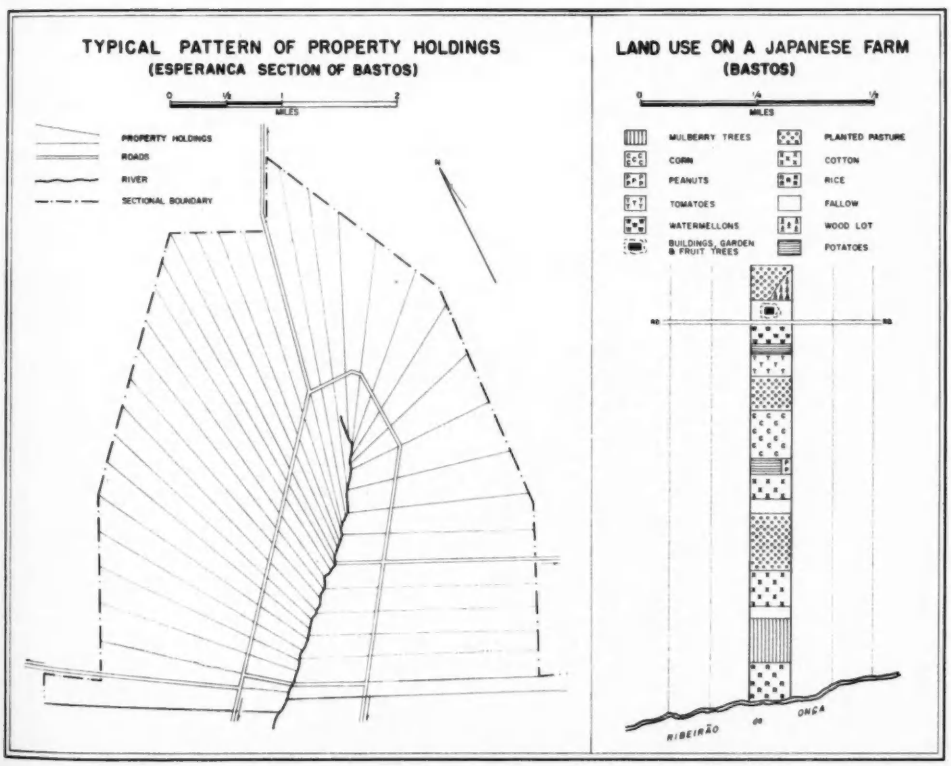

FIGURE 4

swelled to more than 16,000 by 1940, came from no particular locale in Japan. A spot check revealed origins ranging from Hokkaido in the north to Tokyo in the south.

The tract of land purchased by the Sociedade for the establishment of Bastos consisted of about 78,000 acres located in a series of small valleys tributary to the Rio do Peixe. The town was constructed at roughly the center of the tract with roads leading both to the surrounding farms and to nearby communities, especially to Rancharia, the rail center to the south and (later) to Iacri on the Paulista Railroad to the north (see Fig. 3). Division of the tract into farm lots and the location of houses and roads followed patterns typical of colonies of small farmers on the Paulista frontier (see Fig. 4). The farm lots, which are long and narrow, generally lead from the streams to the divides and are divided into two unequal parts by the road running to the town. The smaller section of the divided lot is frequently used for garden, pasture, and fruit trees, and the larger is put into general cultivation.

The original farm size per family was approximately 60 acres, and while this was far more land than the average colonist had been accustomed to in Japan, it was no ready source of wealth. Like much of western São Paulo in the 1920's, Bastos was a forest-covered sertão with extremely limited transport facilities and no social services. The nearest railroad (the Sorocabana)[11] was at Rancharia 25 miles away, and there were no roads. The colonists had to begin by cutting down the forest to clear the land, and then proceed to the construction of roads, schools, and other necessary facilities. In this initial effort, the Bastos Japanese had no help from the Brazilian government. The Sociedade rendered some aid, but the major burden fell upon the colonists themselves. It goes without saying that this initial struggle to establish the colony was a difficult one, and it fully tested the Japanese reputation for hard work and agricultural efficiency.

Like other colonies of small farmers on the Paulista frontier, the agriculture developed at Bastos included both subsistence and commercial crops. Subsistence production emphasized rice, garden vegetables, bamboo shoots, manioc, and other food crops. Commercial production began by experimenting with coffee, but this cash crop was soon abandoned. Coffee at Bastos proved a poor choice not only because of the danger of frost, but also because the small Japanese farmer did not have the capital to make a go of production. Cotton, which was another early introduction, proved ideal for the Japanese as well as other *sitiantes*[12] on the frontier. The arrival of the Bastos colonists coincided with the beginning of large-scale cotton production in all of western São Paulo. Moreover, in the Japanese colonies, cotton planting was strongly encouraged by the Sociedade which was interested in increasing export of the crop to Japan. Production became an almost patriotic duty to help decrease Japan's dependence on U. S. imports, and as a result cotton rose rapidly at Bastos. The first *usina* or cotton mill was established as early as 1931, and after this the colony rose to become the chief cotton producer in all of Brazil,[13] a position she held until recent years.

Another early product of the Bastos economy was typically Japanese—silk. Silk production was originally sponsored by the Brazilian government which was interested in finding new ways of diversifying the agriculture of the frontier. It was the *savoir faire* of the colonists and their ties with Japan, however, which gave rise to the prosperous silk industry at Bastos. At first the colonists were restricted to planting mulberry trees and producing silk worms. Eventually plants for spinning the thread and manufacturing silk cloth were also established, and by the early years of the second World War, Bastos could boast of being the most important silk producer not only in all of Brazil but in all of Latin America. The development of silk manufacturing, like everything else in Bastos, was closely supervised by Japanese authorities before the war. Capital, machinery, and even the technicians for the silk plants were sent from

[11] The Paulista Railroad did not pass to the north of Bastos until several years after the colony was founded.

[12] A "*sitio*" is a small farm and a "*sitiante*" is a small farmer. In this part of São Paulo a farm is not called a "fazenda" unless it measures at least 900 acres.

[13] While cotton production was undertaken by many small farmers in São Paulo, it was the Japanese at Bastos and elsewhere who became the most important producers.

Japan, and the industry was another expression of the intimate association that existed between Bastos and the mother country.

In summary, then, prior to World War II the process of assimilating the Bastos Japanese into the Brazilian national structure had made practically no progress. The colony's ties to Japan through the Sociedade and the Japanese consulate in São Paulo were strong. The Nisei were educated in Japanese schools and insulated from any Brazilian influence. There was only one patriotism and that was for imperial Japan. It was often said, for example, that every Nisei in the pre-war period knew that Hirohito was the Emperor of Japan, but practically none knew the name of the president of Brazil. In sentiment, culture, and loyalty, Bastos was a Japanese island on the Paulista frontier. Even the commercial production of the colony emphasizing cotton and silk was flavored by influence from the mother country. Under these circumstances, it was not surprising that the outbreak of the war created a major crisis in the colony.

For Bastos, as well as other Japanese colonies in Brazil, the wartime period was one of stress and reorientation. When the Japanese consulate in São Paulo was closed, the colony, which had been largely guided by Japanese officials and policies, suddenly found itself without leadership. Worse still, the war made the Brazilian government keenly aware of the potential danger stemming from the unassimilated foreign groups in its body politic. A firm (almost harsh) program of nationalization was directed against all foreigners who had failed to merge into the Brazilian complex, but it was the Japanese at Bastos and elsewhere which the program hit the hardest. The aloofness of the Japanese groups, their racial distinctiveness, and their close ties with an enemy power made them more suspect in the eyes of the Brazilians than other foreign elements, such as the Italians and the Germans. At Bastos the nationalization steps included: (1) a major effort to introduce non-Japanese farmers into the colony; (2) laws forbidding use of the Japanese language in public places; (3) a forced "Christianization"

FIG. 5. Japanese Farm Buildings in Bastos

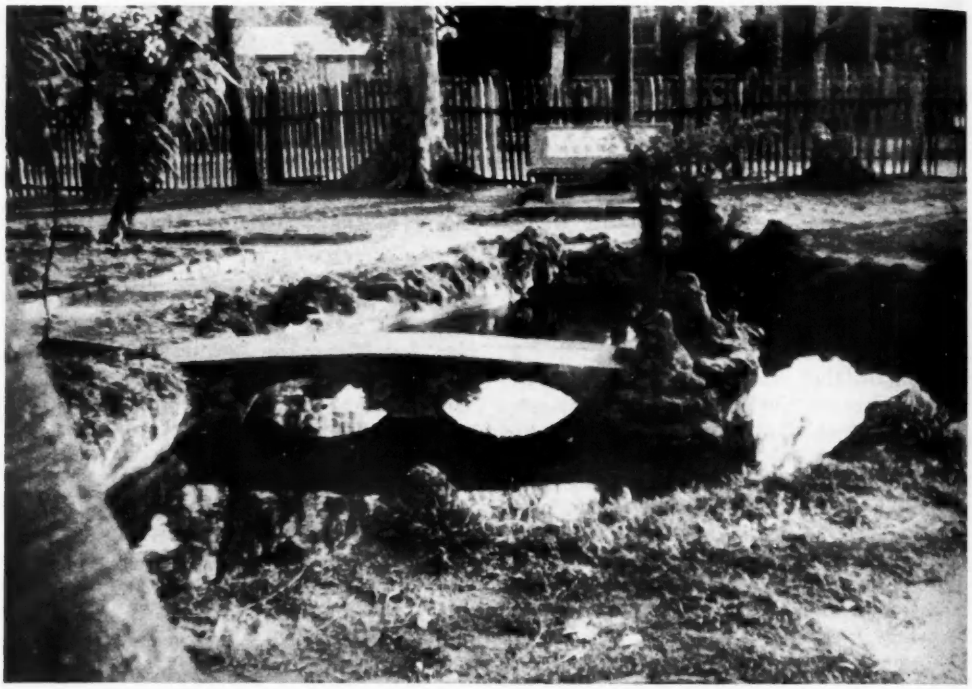

FIG. 6. Nostalgic Beginnings of Japanese Garden and Carp Pond

of Japanese first names; (4) elimination of Japanese schools and replacement by Brazilian instruction; (5) confiscation of property owned by nonresident Japanese; (6) restriction of movement and strict supervision by the Brazilian police. In essence, the Japanese were treated as an anti-national minority whose loyalty to an enemy power represented a threat to the national security of Brazil. So intense was the wartime experience of the colony, so sharp a break did this period represent with the past, that today the colonists divide their history in Brazil into two phases, "before the war" and "since the war."[14]

The defeat of Japan came as a slow shock to Bastos. It took a considerable time for some of the die-hard Japanese nationalists to accept the downfall of their homeland. Bastos was one of the centers in which the more fanatic of these nationalists beat up and even killed those among their people who believed the reports of the surrender of the island empire. Eventually, however, reality had to be accepted even by the most stubborn, and this set the stage for the cultural reorientation which is the mark of the present.

CULTURAL DISTINCTIVENESS OF JAPANESE BASTOS

The observer viewing the Bastos scene more than ten years following the end of the war has little difficulty in determining the origin of the group. As he enters the rural areas occupied by the Japanese, he is made aware of a subtle landscape change. The fields are well tended, crop associations are different, and there are more fruit trees and flowers. Rice straw is widely used for roofing farm sheds, and bamboo is apparent both in the fields and in the construction of farm buildings (see Fig. 5). If it is the wet season, he

[14] The war proved to be a boon to Bastos in one respect, however — it gave strong impetus to the expansion of the silk industry. When imports of silk were cut off from Japan and Italy, Bastos and other Japanese centers in Brazil, such as Pereira Barreto, Fernão Dias, Lins, Bauru and others, found themselves in the unique position of being about the only silk producers in the Americas. The price of silk cocoons rose to unprecedented heights and in answer to the demand, the Bastos colonists planted more land in mulberry trees, built new factories, and experienced a typical boom.

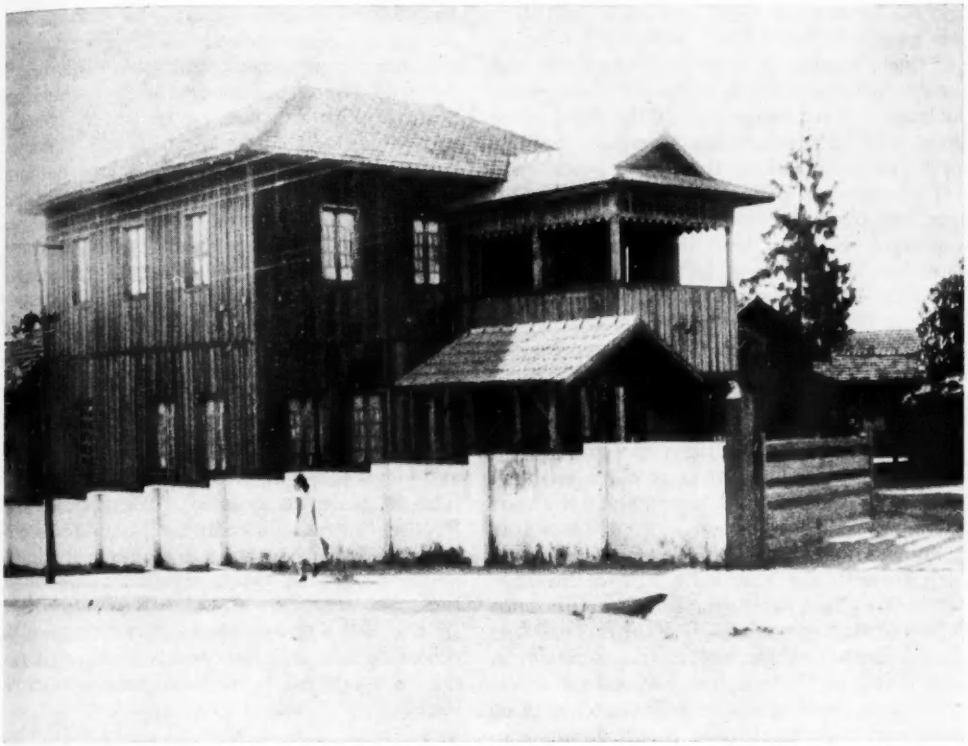

FIG. 7. Subtle Suggestion of Nippon in Architecture of Bastos Building

may even see paddy rice and the Japanese farmer and his wife, complete with conical straw hats, working barefooted in the fields. As the observer approaches the town of Bastos, he sees the Nisei playing baseball, quite in contrast to the "futeball" which is common in most of São Paulo state.[15] In the town he is immediately aware of the almost total absence of non-Japanese. The signs over the stores are oriental, the language spoken and the music blaring from the homes are Japanese. So too is the film being presented at the local theater.[16] Japanese books, newspapers, magazines, and even mechanical equipment, such as jeeps and sewing machines, are everywhere in evidence. The appearance of houses and other buildings, however, differs little from non-Japanese construction in Tupã, Varpa, and elsewhere in the region. Occasionally one may see the nostalgic beginnings of a Japanese garden or a façade with the subtle suggestion of Nippon (see Figs. 6 and 7), but these are exceptional. The construction in the town, in contrast to that in the countryside, was done by Italian stone masons.

On closer observation, some modification of things Japanese is apparent, but altogether the retention of the mother culture is still strong. The older generation at Bastos speaks only Japanese, but the Nisei also speak Portuguese. Amongst themselves the younger element uses both languages freely. The nationalization of Japanese schools by the Brazilian government during the war did not eliminate the teaching of Japanese. Most of the children continue to be taught the language of their fathers at home or in private schools,

[15] The Japanese brought baseball into this part of Brazil, and Bastos has produced a number of championship teams. The author was asked to send a copy of the latest baseball rule manual from the United States so that the Bastos team could keep abreast of new regulations.

[16] The theater owner charges 500 percent more for a Japanese film than for a Brazilian, American, or European. Yet, he packs the house with a Japanese film and gets only moderate to poor attendance with other films.

and the number of Nisei who claim that they are unable to read or write Japanese is extremely small. So widespread has been the use of Japanese that even the few Europeans, such as the German doctor and the Portuguese priest who live in the colony, have learned the language and use it as their own.

The retention of Japanese culture is also apparent from the small percentage of intermarriage between the Bastos colonists and Brazilians. Officials at Bastos indicated that less than a dozen such marriages had taken place in the colony's thirty-year history.[17] In part this low rate of intermarriage seems to have been due to the limited contact which the Bastos youth had with other Brazilians, but in part it has also been due to the Japanese practice of permitting the parents to select the bride and arrange the marriage. This custom has been changing since the war, however, and most young people are now being permitted to make their own selection. Significantly, the Nisei who "go to the city" are more prone to intermarriage with non-Japanese than those who remain at Bastos.

And Bastos retains its Japanese flavor in innumerable (though less important) other ways. In a country where coffee is consumed in enormous quantities, tea is still the favorite drink of the Japanese. The diet of the group has undergone only slight change—rice is still the central dish. The large use of vegetables, bamboo shoots, soy sauce, fish, the ever-present chopsticks—all proclaim the Japanese origin of the group;[18] so too do the carp found in the small pond of the local hotel, the flower arrangements and the prints of Japanese landscapes in the home; the shrines to the various gods in the Buddhist tradition, the Japanese flag displayed on special occasions, the Japanese games taught to the youngsters. There can be no mistaking the origin of the group.

The high retention of Japanese characteristics at Bastos is due to many causes, but perhaps the most important is the almost constant circulation maintained between the colony and the old cultural hearth in Japan. Before the second World War, of course, Bastos was under the complete supervision of Japanese authorities. The war and the Brazilian nationalization program weakened but did not break the hold which the mother country held on Bastos. With the coming of peace, contact with Japan was again established. Japanese books, newspapers, and movies are pouring into the colony; immigrants from Japan are again arriving (though in smaller numbers than before the war); commercial exchange has been reopened, particularly in connection with the silk industry, and Japanese capital, technicians, machinery, and other equipment are aiding the revival of silk production in Bastos. The bond with Japan is also kept strong by some of the more fortunate older colonists who are fulfilling their desire to visit their homeland once more before they die, and by an occasional student who may be sent from Bastos to study at a Japanese university. Finally, the relation with the Japanese consulate in São Paulo, while not a strong, formal one as before the war, is again apparent. The Japanese consular officials frequently visit Bastos, and a warm cordiality exists between these officials and the colonists. None of the other foreign groups in the region, such as the

TABLE 1.—SELECTED AGRICULTURAL STATISTICS FOR BASTOS MUNICIPIO, 1955[1]

Crops	
Cotton	900,000 kilos
Peanuts	125,000 kilos
Coffee	7,500 kilos
Rice	210,000 kilos
Sweet potatoes	150,000 kilos
Corn	378,000 kilos
Lemons	75,000 dozen
Oranges	58,330 dozen
Livestock on Farms	
Cattle	7,000
Horses	950
Swine	2,400
Chickens	575,000
Animal Products	
Eggs	4,300,000 dozen
Milk	600,000 liters
Butter	1,500 kilos
Cheese	10,000 kilos

[17] The author met the offspring of only one such marriage. This was a girl in her early twenties, who was easily the most attractive Brazilian that he saw in all western São Paulo.

[18] The more prosperous of the Bastos families actually import favorite foods (not available locally) from Japan.

[1] Statistics furnished to author by Fadao Haranaka, the "prefeito" or mayor of Bastos. No statistics were available on the production of watermelons, potatoes, and other fruits and vegetables. According to Bastos authorities, fruits and vegetables rank only after eggs and silk in the commercial output of the colony. Statistics do not cover that part of the Bastos colony which extends beyond the municipal limits.

Latvians of Varpa and the Italians or Germans of Tupã, have retained the strong bonds with their country of origin which the Bastos colonists have with Japan.

ECONOMIC TRENDS AND PATTERNS

Economic trends at Bastos reflect both a Japanese influence and the notorious instability of the Brazilian pioneer fringe. Whenever possible, the colonists have given emphasis to those crops and specialties with which they were already familiar in their Japanese homeland. Rapidly shifting market possibilities and other forces, however, have made necessary quick changes in commercial production, especially since the war. The most important of these changes in the postwar decade are associated with the decline of cotton and the rise of egg production; the reorganization of the silk industry; and the diversification of agriculture, placing more emphasis on specialty crops and animals.

Cotton, often called white gold by the colonists, was associated with the initial economic development of the colony, but has been declining steadily since the war. This decline stems from several causes, chief among which are: (a) decreasing yields due to soil depletion; (b) unstable market conditions and sharply fluctuating prices; (c) weaker commercial ties with the Japanese market following the war; (d) competition from newly opened lands farther west whose soil is still virgin; (e) the high costs of fertilizer and insecticides.

To fill the void created by the downfall of cotton, Bastos has been giving stronger emphasis to animal husbandry, especially egg production, in the last ten years. Flocks of Leghorns[19] numbering more than one half million have been rapidly developed in the colony, and in 1955 the municipio alone produced more than 4,000,000 dozen eggs. The eggs are sold primarily in São Paulo and other urban centers in the state, and the money derived from these sales now represents the chief cash income of the colony. Thus Bastos, which was once Brazil's chief cotton producer, has now become the country's principal egg producer.

[19] Some Rhode Island Reds are to be found, but since these are better for meat than for eggs they are not numerous. Bastos is still too remote from large urban markets and has other transport difficulties which prevent meat shipments.

Silk has been important in Bastos from the beginning and has always ranked among the first two sources of cash income. During the war, however, the curtailment of silk imports from Japan and Italy gave the industry at Bastos a sharp boost, and silk became even more important than previously. For some time, Bastos produced not only the silk cocoons and thread, but it also manufactured silk cloth for sale in Brazil and for export to other Latin American countries. The immediate postwar period saw a sharp decline in silk production, however, as imports from abroad again became possible. Silk prices tumbled, the factories which manufactured silk cloth in Bastos were forced out of business, and at least part of the land devoted to mulberry trees was cleared for other uses. Beginning about 1953, silk in the colony started on a slow recovery. In 1955 there were almost 4,000 acres in mulberry trees in the municipio alone, and more trees are being planted. About 15 kilos of silk thread are produced daily in the two plants at Bastos, and the thread is then shipped to São Paulo city to be made into cloth. The factories, which are largely owned by nonresident Japanese stockholders, are modern, up-to-date units with research laboratories, the latest machinery, and a large staff of trained technicians imported from Japan. The value of silk production in the colony was set at about 15,000,000 cruzeiros in 1956.

Silk benefits both the rural and urban economies at Bastos. The silk worm eggs which are produced in the factory laboratories are parcelled out to the farm family which hatches the worms, feeds them to maturity,[20] and sells the cocoons back to the factory. The farmer receives slightly more than 100 cruzeiros for a kilo of cocoons, and this is considered an excellent supplementary source of income. Silk production also employs a labor force of almost 200 girls, most of whom live in the town, and this helps to bolster the urban economy. Production of silk seems ideally suited to Bastos not only because of the *savoir faire* of the colonists but also because it is the type of light, high-value product which can withstand the disadvantages of costly transportation on the frontier.

True to Japanese agricultural tradition, Bas-

[20] As in Japan, this is a task done largely by the women of the family.

tos is producing considerable quantities of vegetables and fruit. In fact, watermelons, tomatoes, potatoes, and peanuts follow eggs, silk, and cotton in their commercial importance, while oranges, lemons, and bananas are increasing in production. Cattle raising, particularly zebu for meat, is receiving emphasis, and dairy production of butter and cheese are appearing as important commercial products of the colony (see Table 1). Diversified and relatively intensive agriculture is both a characteristic and a necessity of the small Japanese farm. Intensive use is required by the relatively small size of the farm, and diversification is necessary to guard against the notorious instability of market conditions for agricultural products in Brazil.

Land use on a typical farm of about 130 acres mirrors this diversity and intensity: approximately one-fourth of this is in planted pasture;[21] an additional 20 acres is in mulberry trees; 18 acres are given over to cotton; 20 or more acres may be in corn;[22] about 2 acres are devoted to farm buildings and garden; from 20 to 30 acres are left fallow, and the remainder is in peanuts, rice, watermelons, and general subsistence crops(see Fig. 4).

The agricultural structure of the Japanese colony in Bastos stands in sharp contrast to that of non-Japanese neighbors not only in the nature, diversity and intensity of production but also in such agricultural practices as labor input, fertilization, mechanized equipment and other respects. The Japanese farm is easily distinguished on the landscape. It is prosperous in appearance, more intensively worked, and stands out as the land of a better farmer than that of his neighbors. In a farming region where fertilizer is seldom used, for example, the Japanese uses it to a large extent. It is true, of course, that the high cost of artificial fertilizer makes this prohibitive, but the Japanese uses the excrement from his chickens and cattle on the land.[23] The progressiveness of the Japanese farmer is apparent in other respects. He practices crop rotation, irrigation, and seed selection, and he makes a far greater use of seed selection than other small farmers in the region. Practically every Japanese farmer owns a tractor (see Fig. 8), a motor for pumping irrigation water, and many own trucks and other machinery. Also unlike many of his neighbors, such as the Latvians of Varpa, the Japanese farmer does not have a labor force problem, and seldom has to employ hired hands or take on sharecroppers.[24] The large size of Japanese families, often ten or more children, and the long hours of work put in by the Japanese mother guard against labor shortage. As one Brazilian of German origin observed, "I work ten hours per day on my land, but my Japanese neighbor works fifteen and his wife may work eighteen hours."

In addition to flocks of chickens which may number from several hundred to several thousand, the animal association on a Japanese farm includes two or three horses and mules used for work and transportation, twenty or more head of cattle, and a pig or two. Farm buildings include a residence, chicken housing, silk sheds, and a general barn. All farms have a cart used for transportation, and a few of the wealthier people have cars or jeeps as well.

The disposal of commercial products and the purchase of farm equipment and supplies is handled largely by cooperatives, of which there are seven at Bastos. Beef cattle are sold on the hoof to dealers who visit Bastos regularly; silk, butter, and eggs are taken to Iacri, Tupã, or Rancharia for shipment to São Paulo and other cities; and watermelons, potatoes, and other perishable vegetables may be taken directly to São Paulo by truck.

From these sales the Japanese farm family derives an annual income which may range from 100,000 to 200,000 cruzeiros. This is roughly $1,500 to $2,500, but its purchasing power in Brazil is considerably greater than its equivalent in the United States.[25] Since the Bastos family is practically self-sufficient in food and spends little on houses and taxes, this income permits a standard of living well above the Brazilian average.[26] Land values in Bastos have been climbing as improvements

[21] The carrying capacity of planted pasture is about half a head per acre.

[22] The Japanese cannot raise all the feed for his chickens on the farm, and much must be bought.

[23] The traditional Japanese fertilizer, night soil, is not widely used.

[24] J. P. Augelli, "Foreign Colonies on the Brazilian Pioneer Fringe—the Latvians of Varpa," to be published in the *Geographical Review*.

[25] These figures were estimates made in consultation with three business leaders in Bastos.

[26] The author's estimate gives the Bastos family an annual income of Cr. 50,000 more than the Latvian family in nearby Varpa.

FIG. 8. Pride and Progress of the Japanese Farmer

have been made by the Japanese. An *alqueire* of land (5.98 acres) which was worth less than 200 cruzeiros in 1930 is now worth from 15,000 to 18,000 cruzeiros. The value of land, stock, and equipment on many Japanese farms at Bastos may be estimated at close to half a million cruzeiros.[27] Despite this progress and apparent prosperity, Bastos is not without its economic problems, problems which are largely responsible for the current decline of the colony.

POSTWAR DECLINE AND CULTURAL CHANGE

The postwar decade has witnessed a definite economic decline and some modifications of the Japanese cultural patterns at Bastos. The total population of the colony, which numbered almost 16,000 at its peak before the war, is barely half that figure at the present, and the trend to population decrease continues. In the last ten years more than 300 families have left Bastos for the Japanese colony of Dorados in the Mato Grosso;[28] other families have gone to Paranâ; and the flow of young people to the towns, especially Tupã and São Paulo, has taken its toll. In small part, the outflow of population has been made up by postwar immigration from Japan and by the coming of Brazilian farmers and cattlemen. These, however, have not been enough to stem the decline.

Evidence of economic decline and cultural change at Bastos are quite apparent. In the town, for example, a number of the largest buildings are abandoned and are falling into disrepair. These include a former silk factory (see Fig. 9), a railroad station which was built in the false hope that a railroad would come to Bastos, the imposing beginnings of a Catholic church which has never been completed due to lack of funds, and numerous

[27] This figure is only the author's estimate, and to some extent it is based on the fact that the Japanese farm at Bastos has been increasing from its original 10 *alqueires* or 60 acres to almost twice this size as the farmers buy the land of those who are leaving.

[28] Apparently the Japanese who move westward with the pioneer fringe do so in "colonies" or groups while those who go to the city go as individuals. The city has its Japanese *barrio* or neighborhood, of course, but the Japanese going to the city breaks from the group more completely.

FIG. 9. Abandoned Silk Factory—Symbol of Economic Instability

other signs. The observer senses a ghost town in the making, but he is informed that decline in the town has been far less than in the countryside. The silk factories, employing a labor force of almost 200 out of a total population of 1,500, have tended to stabilize the urban population.

In the countryside two changes that are evidence of decline have taken place in the last decade: (1) the proportion of Brazilians to Japanese is increasing; (2) land use is becoming less intensive. The first non-Japanese element at Bastos was introduced by the Brazilian government during the war. Beginning with the early 1940's, small farmers of Brazilian background were deliberately encouraged to settle in the colony in order to break the totality of the Japanese hold on the area. A small number of Brazilians came in during this period, but it was not until the area began to be invaded by cattle barons and their retainers in the current decade that the precentage of non-Japanese at Bastos rose significantly.[29] In turn, the cowmen who are buying up the Japanese farms for pasture are introducing a new way of life and a new human element at Bastos.[30] Not only does the land use change and the proportion of Japanese go down, but the cowboy coming in represents altogether different human material from the small farmers, Japanese or Brazilian. The cowboy with his colorful costume is generally a *nortista*, a recent immigrant from the north; he is often colored, his level of education is extremely low, and his drive for work is far less than that of the Japanese.

The coming of cattle also marks another phase in the history of land use at Bastos. In less than 30 years the area has gone from virgin mato to intensive crop cultivation and is now going to pasture as crop production declines. This cycle of land use is not restricted to Bastos alone. It has characterized much of São Paulo's western frontier where coffee raising is marginal. The rapid change in land use is an indication of the instability of settlement and the hollow frontier process which continues in much of interior Brazil.

The decline of Bastos stems from several

[29] Currently this percentage is estimated at between ten and fifteen.

[30] Not all the land left by the people who are moving out is being sold to cattle interests. Some is sold to Japanese farmers who choose to remain.

causes, some of which have been unique to Bastos and others which the colony has shared in general with all of the Paulista pioneer zone. Among these is the problem of transportation which has made the disposal of surplus production a difficult and costly process. Products shipped to market must first be carted from the farm to the cooperative in town. From the town they move by truck either to Iacri on the Paulista railroad or to Rancharia on the Sorocabana. There are at least five loading and unloading breaks before the products reach São Paulo. Not a single paved road is to be found anywhere in the colony, and during the rainy season even the best of the dirt roads become all but impassable. The fact that Bastos was by-passed by both the Sorocabana and the Paulista railroads has in itself been a factor of decline. Railroad towns, such as nearby Tupã, have both greater impetus for growth and greater stability on the volatile Paulista frontier. Bastos, for example, was originally larger than Tupã, but was easily outstripped when the latter received the railroad.[31]

The transportation problem has always been present, however, and while it has undoubtedly contributed to decline, it cannot be considered the dominant factor. Perhaps more significant have been the drop in cotton production, the uncertain market for silk, and the decreasing yields from the "mined" soils of the colony.

As already indicated, the rise of Bastos and other Japanese colonies along the Paulista pioneer fringe were intimately associated with the rise of the Brazilian cotton industry. At the height of production in the late 'thirties and early 'forties, Bastos was Brazil's chief cotton producing center. Since this crop was the colony's chief source of cash income, its decline proved a serious blow. Worse still, the cotton boom had unfortunate consequences upon the productive capacity of the land. Cotton, a robber crop par excellence, quickly drained off the limited fertility of the soils. Artificial fertilizers were considered too expensive, and while the Japanese made greater use of animal fertilizers than their neighbors, this was not enough to offset the decreasing yields.[32] Lack of price stability was in the minds of many even more significant than decreasing yields. Since the Brazilian government does little in the way of farm price support, the farmer is subject to sharp fluctuations in price. During the 1955–56 crop season, for example, the price paid to farmers for cotton at the cotton mills in Tupã ranged from 145 cruzeiros per *arroba* (15 kilos) at the beginning of the season to 50 cruzeiros at the end of the harvest. The same pattern of price instability also applied to other crops, such as peanuts and watermelons, but not to eggs and animal products. This may explain the increasing emphasis on animal products as compared to crops at Bastos. Added to this instability are other farm problems, such as insect pests,[33] the danger of hail, the competition from the newly opened-up lands farther west, and the uncertain future of silk.

Finally, the decline of Bastos must be viewed within the framework of population instability which characterizes the entire Brazilian pioneer fringe. The pioneer fringe is young country where traditions and attachment to the land are weak. Seldom do the same people who clear the forest from the land own this land twenty years later. Development and amazingly rapid progress are the mark of the pioneer front itself, but short distances behind this front decay may set in and a hollow frontier may be created at an equally rapid rate.

In Bastos the abandonment of the land, the decline of population, and other evidence of decay seem to be due to three forces: (1) the already mentioned decline of the cotton and silk industries; (2) the pull of the western frontier; (3) the pull of the eastern cities, especially São Paulo.

In some respects, the Japanese in Bastos have resisted the pull of the western lands more than other small farmers. Their tendency to stay close to the Japanese "group," the continuation of the unique silk industry—these have kept more people at Bastos than might

[31] Tupã was selected as the railroad town because it lay along the "espigão" or ridge along which the line was built rather than in the valley.

[32] One of the characteristics of agriculture along the Brazilian pioneer fringe which the author noted was the almost total disregard of fertilizer. Query on this point always brought the answer that fertilizers were too expensive, and that production on the older lands could not compete with the production of virgin lands if the cost of fertilizers were added to the over-all cost of production.

[33] Particularly destructive here has been a red ant which literally cuts down plants. Locally the ant is called the "sauva."

be there under different circumstances. Eventually, however, even the Japanese succumb to the fever of virgin land at bargain prices, to the magnetism of gambling for a large fazenda and getting rich, to the lure of land speculation which is the strongest force and greatest curse of the Brazilian pioneer fringe. The farmer who has toiled to clear the land and has seen the yields decrease year by year sells to the encroaching cattle baron or to those farmers who stay. The price which is paid him may enable him to purchase a piece of virgin land westward, much larger than the one he is selling. So he moves.

Along with the westward pull of the new land is the eastward pull of the city, particularly São Paulo. The Nisei raised in Bastos who does not go into farming has very restricted opportunities for economic progress. A handful may find employment in the colony's silk establishments and small businesses, but most must leave the area. Japanese families are large—averaging from six to a dozen children. Only one or two of these may hope to make a living from the family farm. Of the rest, those who want to farm may choose to go farther west; the remainder must head for the city with its opportunities in business and the professions. It should be noted that the Japanese place a strong emphasis on education—considerably more than their neighbors. From the earliest beginnings the colony maintained its own schools, both elementary and high school. With wartime nationalization, the Brazilian government closed down all Japanese schools and established a Brazilian school as Bastos, but only through the elementary level. It was the people themselves who gave money to re-establish a high school run by Catholic priests. Every family at Bastos that is financially able to do so sends its boys to high school and even to the university. Those Nisei who receive any degree of advanced education generally go to the city. And so the Nisei of Bastos have been moving to the city in increasing numbers. In the nearby city of Tupã, for example, approximately 40 percent of the population is already Japanese. More significant, however, are the facts that three out of every five business establishments on Tupã's main street are Japanese, and that the vast majority of the students pouring out of Tupã's gymnasium and normal school are also Japanese. Thus, caught between the pull of the new land and the city, the Japanese population is decreasing. Postwar immigration from Japan has helped to fill some of the void created by emigrants, but there are still more people leaving Bastos than are entering. The situation at Bastos might be even worse were it not for the silk industry and for the determination of some of the Nisei to keep Bastos going as a symbol of Japanese colonization in Brazil. As one young Nisei leader put it—"Bastos is the only 'patria' that I have ever known, and I feel it my duty to stay and help Bastos continue."

In addition to general decline, the postwar period at Bastos has also been marked by some cultural modifications. The element principally affected by this change, of course, are the Nisei. This group, which before the war was isolated from non-Japanese influence by education, custom, and the prestige of "Dai Nippon," received the rudest jolt from Japan's defeat. A certain amount of disillusionment with things Japanese was inevitable. Moreover, education ceased to be Japanese and became Brazilian; an increasing number of Nisei left Bastos for the city where they became far more exposed to Brazilian culture; conversion to Christianity affected many. As a result of all these, the Nisei suddenly became aware of being Brazilians—not ordinary Brazilians, but Brazilians who are keenly conscious of their Japanese ancestry and who desperately want to prove the value of the Japanese to the heretofore-prejudiced Brazilian.

Cultural change at Bastos is expressed in many ways—social, economic, and political. For example, the number of contract marriages by parents is sharply decreasing. The Nisei now have greater opportunity for selecting their own brides, and for those in the cities this means a stronger possibility for intermarrying with other races. Until recently the Bastos Japanese took little part in politics. The municipal administration of Bastos was left in the hands of non-Japanese despite the enormous majority of Japanese in the colony. Now, however, free-wheeling young Nisei have taken over the town government and are looking forward to even more active participation in politics. An amazing number of the Bastos Nisei have been converted to Catholicism. In part this is due to the general loss of prestige by Japan after the war. For the most part, however, the conversions may be attrib-

uted to the fact that the local gymnasium is in the hands of Catholic priests who are highly respected for their excellent educational and religious work in the colony.[34] Needless to say, education and religious conversion in the gymnasium go hand in hand.

CONCLUSIONS

The evolution of the Bastos colony may be separated into three phases: (1) the prewar period (1927–41) which was characterized by rapid growth, a strong supervision by Japanese authorities, and a high retention of Japanese culture; (2) the war years, a period of stress which initiated economic and cultural reorientation; (3) the postwar or current phase which is marked by economic decline and further cultural modification. If the present economic and cultural trends continue, the future of Bastos both as an expanding settlement and as a Japanese cultural entity is questionable. The colony is losing more people than it is receiving, and the percentage of Japanese in the total population, while still high, is slowly decreasing. It is conceivable that the current decline, brought on largely by the downfall of cotton, may be stemmed at some future time by the revival of silk and the growth of animal husbandry, but it is difficult to forecast any expansion of the colony on the basis of present trends. The forces of instability which affect the land–people relation on the Paulista frontier seem to have prevailed even over the Japanese determination to "hang together" and form a permanent attachment to the land.

Many factors may determine how long the distinctive Japanese culture will be retained at Bastos, but perhaps chief among these will be the future ties between the colony and the old cultural hearth in Japan. The present bonds, while far weaker than those of the prewar period, are still very strong—stronger than those of any other "foreign colony" with its country of origin. It is difficult to see how these can be maintained for any great length of time, however. The distance factor, the dying off of the older generation, the decreasing immigration from Japan, the reorientation of the Nisei to Brazilian national life—all these factors militate against continuing close relations between Bastos and Japan. If the colony existed in relative isolation and if the Nisei stayed close to home and continued with the farming economy of their fathers, one might conceivably see the continuation of Japanese culture for several generations more.[35] Such, however, is not the case at Bastos. Brazilians are moving into the area, and the Nisei have shown a strong tendency to leave home, particularly for the city where they succumb more rapidly to Brazilian acculturation. The Japanese, like the Germans, will resist absorption into the national life of Brazil longer than some other groups, such as the Italians, the Spaniards, the Portuguese and even the eastern Europeans. Their eventual absorption, however, appears to be only a matter of time.

If Bastos is any proof of the effectiveness of the Japanese as an instrument for peopling the Brazilian frontier, then the effectiveness of the Japanese is high indeed. In the Paulista sector of the frontier, the Japanese is highly respected even though he does not mix easily and is still considered somewhat mysterious by some of the other colonists. He is rated as an excellent farmer, a businessman that can be trusted, and a type very prone to progress and innovation; his greater drive has already elevated him above neighbors whose opportunity has been equal to his; he works harder than other people and he tends to educate his children to a higher degree. The Bastos farm, for example, has more mechanical equipment than that of non-Japanese farms in the area. The number of Japanese children in the high schools of Bastos and Tupã, as well as the percentage of Japanese businessmen in these towns, is far greater than the corresponding ratio of Japanese to other groups in the total population. Moreover, the Japanese have larger families than their neighbors, and this is an important factor in the peopling of a frontier.

While Japanese cultural adjustment to the Brazilian national scene may be far slower than that of other immigrant groups, Bastos leaves little doubt that as an instrument for occupying the land and peopling the Brazilian frontier, the Japanese may well be the most effective ingredient available in the Brazilian melting pot.

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[34] The religious services in the Bastos Catholic church are held in both Portuguese and Japanese. Even prayer books have been translated to Japanese.

[35] Note the retention of cultural identity by the German colonies of Santa Catariná and Rio Grande do Sul.

LOCATION OF MANUFACTURING: METHODS OF MEASUREMENT

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THE 1954 United States *Census of Manufactures* offers a new mass of data for research by manufactural geographers. The purposes of this article are: (a) to urge collaborative research efforts by industrial geographers working with these new statistics, (b) to consider classification of methods of measurement, (c) to comment briefly on mapping changes in location of manufacturing, and (d) to suggest two specific problems of measurement for investigation by manufactural geographers.

COLLABORATIVE RESEARCH

Several geographers doubtless will proceed to map manufacturing as revealed by the 1954 census in order to discover new developments in the locational pattern of this activity. The probability of repetitious endeavor suggests that interested scholars pool their efforts. This comment stems from experience. The writer has been involved in one situation already where he, simultaneously with scholars in at least two other institutions, laboriously processed (on punch cards) exactly the same data for exactly the same areas. Time and energy could have been spent more productively if one set of punch cards had been punched—and duplicates run off. Failure of scholars with similar interests to share their research efforts will repeat such instances of wasted time. Economic geography's manpower should be deployed with the 1954 *Census of Manufactures* so as to investigate the largest number of techniques for applying the largest number of methods to the largest number of criteria for the largest number of type groupings of areal units.[2]

CLASSIFICATION OF METHODS FOR MAPPING MANUFACTURING

Implicit in the literature on mapping manufacturing (to be noted later) is the assumption that some methods are preferred to others. Some scholars imply that number of employees is a better criterion than number of factories, or that value added is the best of all. To this writer such arguments seem pointless. No single criterion or single complex of criteria can give a map of total manufactural geography—unless all the variables have a high correlation in their locational pattern, in which case mapping any one variable would do as well. But if the correlation of patterns is low, then each criterion reveals a distinctive aspect of the areal differentiation of one characteristic (or complex of characteristics) of manufacturing. It is not "better than" or "inferior to" any other variable. It is valuable exactly in terms of what it shows of the phenomenon mapped. By analogy one could question the wisdom of arguing whether a map of the variation of height of people is "better" than a map of variation of weight. If the correlation is high, either map would be a good description of somatic variation. If the correlation is low, there is little point in arguing which map is a better map of such differentiation. Both are fundamental to a geography of somatic characteristics. Yet no map combining weight and height (whether the values plotted are "weight times height," or "weight divided by height," or "weight times height divided by average weight times height," or another derivative developed to express a combination of those characteristics in some rational way) will give a "best" map for somatic geography. Likewise, instead of contending that one pattern is a "better" visual expression of the spatial variation of manufacturing, many geographers recognize that each pattern (whether of employees, or value added, etc.) reveals a distinctive perspective of manufacturing's geography. The challenge is to learn all we can of explanations for every pattern and then to use each pattern in furthering knowledge of manufacturing *per se* and the general regionalization of economic activity.

Numerous measurements of manufacturing are available, and theoretically the methods

[1] The author acknowledges helpful criticisms of this manuscript from colleagues Richard Hartshorne, Arthur Robinson, and Andrew Clark.

[2] The author would be happy to hear from colleagues interested in such an effort and share information with them. Perhaps a session at a future meeting of the Association could be devoted to reports of research in this field.

for processing them are so numerous that the task will be simplified if the many methods are classified into a few categories. For illustrative purposes, the United States will be considered as the case study area in this article, and counties have been selected arbitrarily as the areal units for casting the illustrations.

The bases for the classification are as follows: (1) Number of units of measurement employed. Those employing one unit at a time are distinguished from those employing two at a time. (2) Number of areas involved. Measurements involving just one area are distinguished from those involving two areas simultaneously.

On these bases, five categories of methods can be distinguished:

1. Methods involving *one unit* of measurement.
2. Methods involving a ratio between *two units* of measurement in *the same area.*
3. Methods involving a ratio between the *same unit* of measurement *for two areas.*
4. Methods involving a ratio between *two units* of measurement for *two areas.*
5. Methods involving a differential between an absolute value and a ratio.

Ideally, at this point the author wishes he had substantive evidence to demonstrate all these methods. The purpose here is to present a frame of reference within which industrial geographic scholars can work to fill in voids in our knowledge. Appearance of the 1954 *Census of Manufactures* is an ideal time for a cooperative research effort by several analysts to test these methods.

Methods Involving One Unit of Measurement

The simplest method of mapping manufacturing is to plot each areal unit in terms of one absolute value. The 1954 *Census of Manufactures* quantifies eight of these: total number of establishments, number of employees, payroll, number of production workers, number of man-hours, wages paid, value added by manufacturing, and capital expended in new development. Previous censuses tabulated such measurements as value of product, value of raw materials, and horse power of prime movers. From still other sources one might procure data on physical quantity of production, area of floor space, etc. Obviously the spatial analyst has a wide range from which to choose a measurement.

Several scholars have applied this method to a variety of individual measurements. For example, Sten de Geer used "number of wage earners" for cities with 10,000 or more population.[3] Gunnar Alexandersson used "number of employees" as a basis for what is probably the most detailed series of maps ever constructed of United States manufacturing.[4] Helen Strong adopted the criterion of "horse power of prime movers;"[5] Alfred Wright[6] and Victor Roterus[7] preferred "value added." Each of these writers gave reasons for his choice; most pointed out disadvantages in using other individual criteria.[8] Doubtless, each criterion demonstrates the areal differentiation of one or another aspect of manufacturing. Which one is "best" depends on the purpose of the analyst. Most analysts appear to have been interested mainly in "number of employees" or "value added."

In any case, release of the 1954 *Census of Manufacturers* creates opportunity for statistical analysis and mapping of several criteria to see what difference (if any) exists between the locational patterns revealed by each. If the resulting maps are similar regardless of the unit of measurement, the question of which measure is best for mapping purposes does not arise. But manufactural geography needs to know if these individual criteria vary in the regional patterns they produce and, if so, how.

Methods Involving Ratios between Two Units of Measurement in Same Area

Additional insight into the locational pattern of manufacturing is provided when one measurement of manufacturing is compared with another measurement in the same area.

[3] "Delimitation of the North American Manufacturing Belt," *Geografiska Annaler* (1927), pp. 247–58.

[4] *The Industrial Structure of American Cities* (Stockholm, 1956, and Lincoln, 1956), pp. 27–91. The locational pattern of each of fourteen manufactural industries is presented in a series of well-constructed maps showing the employment in every city of 10,000 population as well as in many smaller places.

[5] "Regions of Manufacturing Intensity in the United States," *Annals,* Association of American Geographers, Vol. XXVII (1937), pp. 23–43.

[6] "Manufacturing Districts of the United States," *Economic Geography,* Vol. 24 (1938), pp. 195–200.

[7] "Value Added by Manufacture and Its Significance," *Virginia Economic Review,* Vol. 1 (1938), pp. 1–3.

[8] See also C. F. Jones, "Areal Distribution of Manufacturing in the United States," *Economic Geography,* Vol. 24 (1938), pp. 217–22.

Using only the 1954 census it would be possible to construct not less than 28 maps since each of the eight measurements could serve as the numerator in seven different ratios involving the other seven as denominators. Examples of such ratio maps are:

Number of production workers/number of employees
Number of employees/number of establishments
Value added/number of employees
Value of payroll/value added
Capital expended on new development/value added

Additional ratios can be based on measurements from other sources, such as total employment, total population, employed labor force, number of farmers, employees in retail trade, employees in wholesale trade, employees in any of several other occupations, median family income, or quality of housing. Examples of ratios then possible are:

Number of manufactural employees/employed labor force
Number of manufactural employees/population
Number of manufactural employees/number of farmers.[9]
Value added/population
Value of payroll/median family income

In any case, the method here is to equate the measurement of one aspect of manufacturing with another of either manufacturing or a related phenomenon in the same area.

Methods Involving Ratios between One Unit of Measurement for Two Areal Units

The amount of manufacturing in a county can be expressed as a percentage of the total amount of manufacturing in a larger area of which the county is a component. For example, the value added in each county can be quantified as a percentage of the nation's total value added. The resulting map for any *one* period of time would reveal exactly the same locational pattern as a map based on the single value of the numerator only (i.e., each county's absolute value added). However, when two or more periods of time are involved, the series of ratio maps could present a different story than the series of single value maps, especially if the numerator values change at a markedly different rate than the denominator values.

The time and effort for calculating these ratios probably should be reserved for the mapping of changes through time.

Methods Involving Ratios between Two Units of Measurement for Two Areal Units

More complex is the method of comparing a ratio within a county with a comparable ratio for a larger area (e.g., the nation) of which the county is a component. Quantification of the difference can be relative or absolute. The relative method expresses a county ratio as a percentage of a larger area's ratio. Several examples are listed below. For convenience the following abbreviations are used: Co.—county; U.S.—United States; EM—number employed in manufacturing; ELF—number in the employed labor force; VA—value added; N—number of factories; VP—value of payroll; P—population.

$$\frac{\text{Co. EM}}{\text{Co. ELF}} \Big/ \frac{\text{U.S. EM}}{\text{U.S. ELF}} \qquad \frac{\text{Co. VA}}{\text{Co. P}} \Big/ \frac{\text{U.S. VA}}{\text{U.S. P}}$$

$$\frac{\text{Co. EM}}{\text{Co. P}} \Big/ \frac{\text{U.S. EM}}{\text{U.S. P}} \qquad \frac{\text{Co. EM}}{\text{U.S. EM}} \Big/ \frac{\text{Co. ELF}}{\text{U.S. ELF}}$$

$$\frac{\text{Co. VA}}{\text{Co. EM}} \Big/ \frac{\text{U.S. VA}}{\text{U.S. EM}} \qquad \frac{\text{Co. VP}}{\text{Co. VA}} \Big/ \frac{\text{U.S. VP}}{\text{U.S. VA}}$$

$$\frac{\text{Co. EM}}{\text{Co. N}} \Big/ \frac{\text{U.S. EM}}{\text{U.S. N}} \qquad \frac{\text{Co. EM}}{\text{Co. emp in activity x}} \Big/ \frac{\text{U.S. EM}}{\text{U.S. emp in activity x}}$$

$$\frac{\text{Co. N of small factories}}{\text{Co. N of factories}} \Big/ \frac{\text{U.S. N of small factories}}{\text{U.S. N of factories}}$$

Harold McCarty applied this method in delimiting counties which had more manufacturing than the national per capita average and to those where the ratio of manufactural employment to wholesale trade employment exceeded the nation's ratio as a whole.[10] The "location quotient" devised by Florence, Fritz, and Gilles

[9] H. McCarty, *The Geographic Basis of American Economic Life* (New York, 1940), p. 482.

[10] *Ibid.*, pp. 482, 483.

is this type of ratio between two local measurements and the national average.[11] Thompson combined a series of such ratios in which each nominator represented the ratio for a Standard Metropolitan Area and the denominator the summation ratio for fifty standard Metropolitan Areas.[12] He went a step further, summating three different ratio values and dividing by three to produce an average of the trio.

The second method quantifies the absolute difference between the two ratios and is expressed as "excess percentage." For example,

$$\frac{\text{Co. EM}}{\text{Co. ELF}} - \frac{\text{U.S. EM}}{\text{U.S. ELF}} \qquad \frac{\text{Co. VA}}{\text{Co. P}} - \frac{\text{U.S. VA}}{\text{U.S. P}}$$

The author knows of no published efforts at mapping manufacturing for a given year according to this second method of combining the ratios of two areal units.

Methods Involving a Differential between an Absolute Value and a Ratio

Another method for mapping manufacturing is plotting each county in terms of excess above a selected datum plane. Probably the most meaningful datum plane is a ratio of some sort. For example, county X has 20,000 manufactural employees and a population of 100,000, producing an $\frac{EM}{P}$ ratio of 20 percent. Suppose that the nation as a whole has a ratio of 12 percent. County x could be quantified as having an excess of 8,000 manufactural employees, as follows:

$$\text{Co. EM excess} = \text{Co. EM} - \text{Co. Pop} \times \frac{\text{U.S. EM}}{\text{U.S. Pop}}$$

Other differentials which might be promising for understanding the regional variations in manufacturing are:

$$\text{Co. VA excess} = \text{Co. VA} - \text{Co. EM} \times \frac{\text{U.S. VA}}{\text{U.S. EM}}$$

$$\text{Co. WS (wages and salary) excess} = \text{Co. WS} - \text{Co. VA} \times \frac{\text{U.S. WS}}{\text{U.S. VA}}$$

$$\text{Co. VA excess} = \text{Co. VA} - \text{Co. Pop} \times \frac{\text{U.S. VA}}{\text{U.S. Pop}}$$

This method was applied in Hartshorne's measurement of excess number of manufactural wage earners above a fraction of ten percent of the county's population,[13] that is:

$$\text{Co. excess} = \text{Co. wage earners} - \frac{\text{Co. Pop.}}{10}$$

McCarty identified counties with excess manufactural value added above the national county average, as follows:[14]

$$\text{Co. excess} = \text{Co. VA} - \frac{\text{U.S. total VA}}{\text{U.S. number of counties}}$$

These are five types of methods for processing quantitative expressions of manufacturing to show regional variation. Obviously there can be numerous additional schemes for combining the above methods, but whatever the combination, it generally will be a blending of absolute values, or of the types of ratios just cited, or of differentials.

METHODS FOR MAPPING CHANGES IN MANUFACTURING

The problem of comparing changing patterns is of interest if one thinks of the nation's economy as dynamic and of the patterns themselves as representative of temporary characteristics of a changing phenomenon. Study of changes in regionalization of manufacturing may be made in at least two ways: (1) quantifying the difference in a criterion between two periods of time by areas and (2) regionalizing change itself by which method areas are mapped not in terms of any one criterion but in terms of categories of change into which they have been classified by a classification system.

The first method involves application of any of the several foregoing methods to two periods of time and quantifying the difference, area by area. This presents two alternative means of expression: (1) subtracting the earlier value from the later (for methods 1 and 5 above the result will be an absolute figure, either plus or minus, signifying gain or loss; for methods 2, 3, 4 the result will be expressed as "change in percent") or (2) dividing the earlier value

[11] P. S. Florence, W. G. Fritz, and R. C. Gilles, "Measures of Industrial Distribution," *Industrial Location and National Resources*, United States Government, National Resources Planning Board (1943), p. 107.

[12] J. H. Thompson, "A New Method for Measuring Manufacturing," *Annals*, Association of American Geographers, Vol. XLV (1955), pp. 416–36.

[13] R. Hartshorne, "A New Map of the Manufacturing Belt of North America," *Economic Geography*, Vol. 22 (1936), pp. 45–53.

[14] *Op. cit.*, p. 483.

into the later measurement (for all five cases this results in "percentage change").

Again there arises the methodological question of which method of measuring change is better. Here the historical geographer and manufactural geographer find common ground. The specialist in "geographical change through time"[15] asks the manufactural specialist which units of industry's areal measurement are most meaningful for portraying changes in location. At present the latter can only reply subjectively, indicating his opinion of advantages and disadvantages of the several methods. Until the systems of mapping manufacturing at any one time are appraised scientifically it seems impossible to demonstrate objectively the superiority of any method for quantifying change between two times. Further, there are very few maps which the manufactural geographer can show his historical colleague to illustrate how different methods work. Wright mapped by nine census regions the locational pattern of new investment in manufacturing as reported by the United States government expenditures. He also tabulated, by the same regions, the percentage change in the absolutes of value added, in wage earners, and in wages paid.[16]

A finer scale of detail was adopted by Edmund Day who mapped, by the forty-eight states, the change in manufacturing between 1899 and 1923. He combined the two units of measurement by computing the percentage increase in wage earners, multiplying this figure by a factor of 3, adding the percentage increase in primary horsepower, and dividing the sum by 4 to give a measurement of change in manufacturing.[17]

A still finer scale was used for the period 1939–47 in mapping the nation's entire array of counties in terms of both absolute increment in number of production workers and percentage increase in the same criterion.[18] Little has been done in mapping changes according to the many other available criteria under method 1 in the foregoing classification. As far as the writer knows, geographical publications contain no maps to any great degree of areal detail demonstrating the application of methods 2, 3, 4, and 5 to changes in manufacturing. However, Wilbur Zelinsky presented a paper to the Association reporting an experiment with two ratios, production workers/population and value added/production workers.[19]

The second method for mapping changes in manufacturing (e.g., between 1947 and 1954) is in terms of categories of county types into which all counties are classified on the basis of their manufactural change. For example, a county where number of factories declines, employment holds steady, and value added rises sharply is of a different type than one where number of factories holds steady and employment declines while value added increases with the national average.

Whether maps are in terms of differentials between two periods of time or in terms of categories of changing counties, the mapping of change in manufacturing's locational pattern is a frontier on which both the historical geographer and manufactural geography can join forces in developing a methodology.

METHODOLOGICAL QUESTIONS FOR INVESTIGATIONS

Experimentation in methodological development can proceed, it would seem, in search of answers to two broad but related questions.

The first is to seek a measure of correlation between the several individual criteria (cited under method 1) as they vary throughout the 3100 counties (or whatever areal unit one selects.) Are the leading counties in number of factories likewise the leaders in terms of manufactural employment, value of payroll, value added? If so, the geographer's maps would portray corresponding locational patterns no matter what the criteria. The same principle applies to ratio measurements (under methods 2, 3, 4, and 5). At this point one wonders if the time required to develop a multiple-criteria-measurement reveals something which would not be revealed by any of the individual criteria alone. For example,

[15] A. H. Clark, "Historical Geography," in *American Geography, Inventory and Prospect* (Syracuse, 1954), p. 71.

[16] A. J. Wright, "Recent Changes in the Concentration of Manufacturing," *Annals*, Association of American Geographers, Vol. XXXV (1945), pp. 144–66.

[17] *The Growth of Manufactures 1899–1923*, Bureau of the Census Monograph VIII (1928), pp. 15–31.

[18] J. W. Alexander, "Industrial Expansion in the United States," *Economic Geography*, Vol. 28 (1952), pp. 128–42.

[19] W. Zelinsky, "A New Approach to the Study of Changes in the Distribution of Manufacturing in the United States, 1939–1947," *Annals*, Association of American Geographers, Vol. 47 (1957), pp. 185–86.

does Thompson's interesting idea produce a pattern which, to any significant degree, differs from that which would have resulted from mapping any *one* of the ratios he employed in the multiple ratio? He believes it would on the basis of a selected example in which the ratio of manufactural employment in the Fall River-New Bedford Standard Metropolitan Area was 108 percent that in the Kansas City Metropolitan Area while the former's value added was only 50 percent of Kansas City's.[20] This example plus casual inspection of the data as well as one's intuition suggest that the several single units of measurement as well as the ratios do vary differently from county to county. But nobody has demonstrated what the relative variation is. Industrial geography needs a correlation analysis to discover which criteria tend to vary similarly from county to county, which tend to vary dissimilarly, and to what degree they differ in those variations.

The main fruit of such correlation studies would be that the industrial geographer at last would have some notion of the difference in significance of different criteria through analysis of differences in patterns, if such differences were apparent. If not, a high coefficient of correlation between any two variables would suggest that one had little need for expending time in constructing a map of each. However, in such instances the geographer might well be interested in mapping the anomalies (i.e., the minority of exceptions) to reveal unusual areas which prevent the overall patterns from being perfectly coincident.

Moreover, there is a new field of study in the investigation of areal differentiation of the degree of correlation. We can find the mathematical degree of correlation without cartographic aid. This is simply a statistical problem. What we feel we can contribute as geographers is the relating of different degrees of correlation to areal differentiation of other kinds.[21]

The second question for investigation calls for evaluation of the several methods of measurement noted. Should the above coefficients of correlation be low, one wonders which criteria give the most meaningful locational pattern. The writings already cited recognize advantages and disadvantages for several measureables, but the discussions are essentially the opinions of the individual scholars. Scientific demonstration of any particular criterion's superiority has yet to be made. The temptation will be strong to assume that a map based on a complex ratio is "better" than one based on a simple measurement. Surely complexity of computation in itself is not evidence that a method is superior, or that simplicity of computation is inferior.

A contribution to industrial geography needs to be made by scholars who will not only process the 1954 *Census of Manufacturing* data in a variety of ways but also will demonstrate what each method reveals of spatial variation of manufacturing and the meaningfulness of each method for purposes of geographical analysis.

SUMMARY

The United States *Census of Manufactures* provides industrial geographers with a statistical harvest challenging scholars not only to discover changes in the locational pattern of industry but also to develop the methodology of mapping manufacturing. To maximize the fruit of research, manufactural geographers should coordinate their investigation of the largest feasible number of analytical techniques applied to the optimum number of criteria for the largest number of areal units for which manufactural data are available.

The concept of a "best" method for measuring and mapping manufacturing is challenged on the premise that every criterion and every method reveals a distinctive meaningful perspective of industry's locational pattern.

Numerous methods for measuring manufacturing by areal units are classified into five major categories: (1) those involving a single measurement for each area, (2) those involving ratios of *two measurements* for the *same area*, (3) methods involving a ratio between the *same unit* of measurement for *two areal units*, (4) methods using ratios between *two units* of measurement applied to *two areal units*, and (5) methods employing a differential between an absolute value and a ratio. To

[20] *Op. cit.*, p. 417.

[21] Background readings for such investigations are J. K. Wright, "Some Measures of Distribution," *Annals*, Association of American Geographers, XXVII (1937), pp. 177–211; Arthur H. Robinson and Reid A. Bryson, "A Method for Describing Quantitatively the Correspondence of Geographical Distributions," *ibid.*, Vol. XLVII (1957), pp. 379–91.

my knowledge, very few of these methods have been applied to the mapping of manufacturing.

Changes in the locational pattern of manufacturing can be mapped either in terms of differences in an area's measurement between two time periods or in terms of categories of change to which each area belongs.

Specific questions for research are a correlation analysis of the many measurements to discover how they covary among the areal units and an effort to test objectively the several methods of measurement to determine which, if any, are the more meaningful for geographical analysis.

SUITCASE FARMING IN SULLY COUNTY, SOUTH DAKOTA[1]

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University of Kansas

THE term "suitcase farmer" is well known in the Great Plains wheat growing areas, although the number of this type of operator varies greatly from one area to another and even from one county to another. Reports about the number of suitcase farmers are usually exaggerated, as was pointed out in an earlier report of ours which deals largely with sidewalk and suitcase farmers.[2] This earlier report classified farmers into rural, sidewalk, and suitcase and explained the application of these terms. The present report applies the term "suitcase farmer" in the same manner, i.e., to land operators who live 30 miles or more from the border of the county where the farm land is located. Apparently distances of 30 miles or more call for the use of a suitcase because one or more nights may be spent away from home to carry out various field operations.

Our first study of sidewalk and suitcase farmers was made in the summer of 1950. Since then seven additional counties, including Sully County, South Dakota, have been investigated. Sully was the only county we found where suitcase farmers exceeded the number of sidewalk farmers.

This report deals primarily with suitcase farming in Sully County. The extent of its development will be noted, methods of operation will be described generally, and the factors leading to its development will be explored. No final or definitive answers will be attempted because the larger study of which this report is a part was planned and executed to give spot checks on sidewalk and suitcase farming in different types of farming areas in the wheat belts rather than to concentrate on only one or several counties which might or might not have proved typical or revealing for larger areas.

Data presented come mainly from two sources: federal census reports and various records in the county courthouse in Onida, South Dakota.[3] Careful use was made of records of the Production Marketing Administration,[4] which were remarkably well kept and complete for their special purpose. Readers will note some discrepancies between PMA and federal census data with regard to number of farmers and some acreage figures. Census figures for a county credit to that county all acreages reported by farmers living within the county although some of the land farmed may lie outside the county. PMA records, however, concentrate on land lying within a county, and if other land is listed, it can be set aside or excluded from totals. Moreover, PMA records give accurate sizes of tracts or fields, particularly tracts and fields covered by allotment programs. Their simple breakdown of land use is therefore remarkably accurate. All available PMA data on farms were tabulated and checked on a large-scale county map. Since these records listed and covered 516 farmers in 1950, and many more tracts and fields of land operated by

[1] This study was made possible by ONR support. Many of the basic data here presented were gathered by Harry L. Dillingham, a graduate student in the Department of Geography, University of Kansas (1953–54), who spent eight weeks in Sully County in the summer of 1953. Mrs. Dillingham also rendered much service in the field and in the Department processing data and tables for Sully County and other counties studied.

Equally important to the success of this investigation was the full and gracious cooperation of the staff of the Sully County PMA office. Special appreciation is due Glenn D. Hughes, Office Manager of that office. Not only were the excellent records of his office made available for our examination, but Mr. Hughes and his helpers spent much time in interpreting the records and supplying all manner of information regarding local agricultural activities and experiences.

[2] See "A Geographic Study of Population and Settlement Changes in Sherman County, Kansas, Part I: Rural," *Transactions*, Kansas Academy of Science, December 1951, pp. 449–94; "Part II: Goodland, and Part III: Inventory and Prospects," *ibid.*, March 1952, pp. 1–37.

[3] This research program was planned when census reports for 1950 became available. At that time it seemed advantageous to investigate conditions in Sully County as of 1950 so that federal and county data could be compared. Field work, however, was carried out in the summer of 1953 and so various developments were noted and recorded up to 1952. Subsequently the 1954 *Census of Agriculture* became available and was also used when helpful.

[4] Hereinafter referred to as PMA. This federal agency has now been superseded by the Agricultural Stabilization and Conservation Program Service.

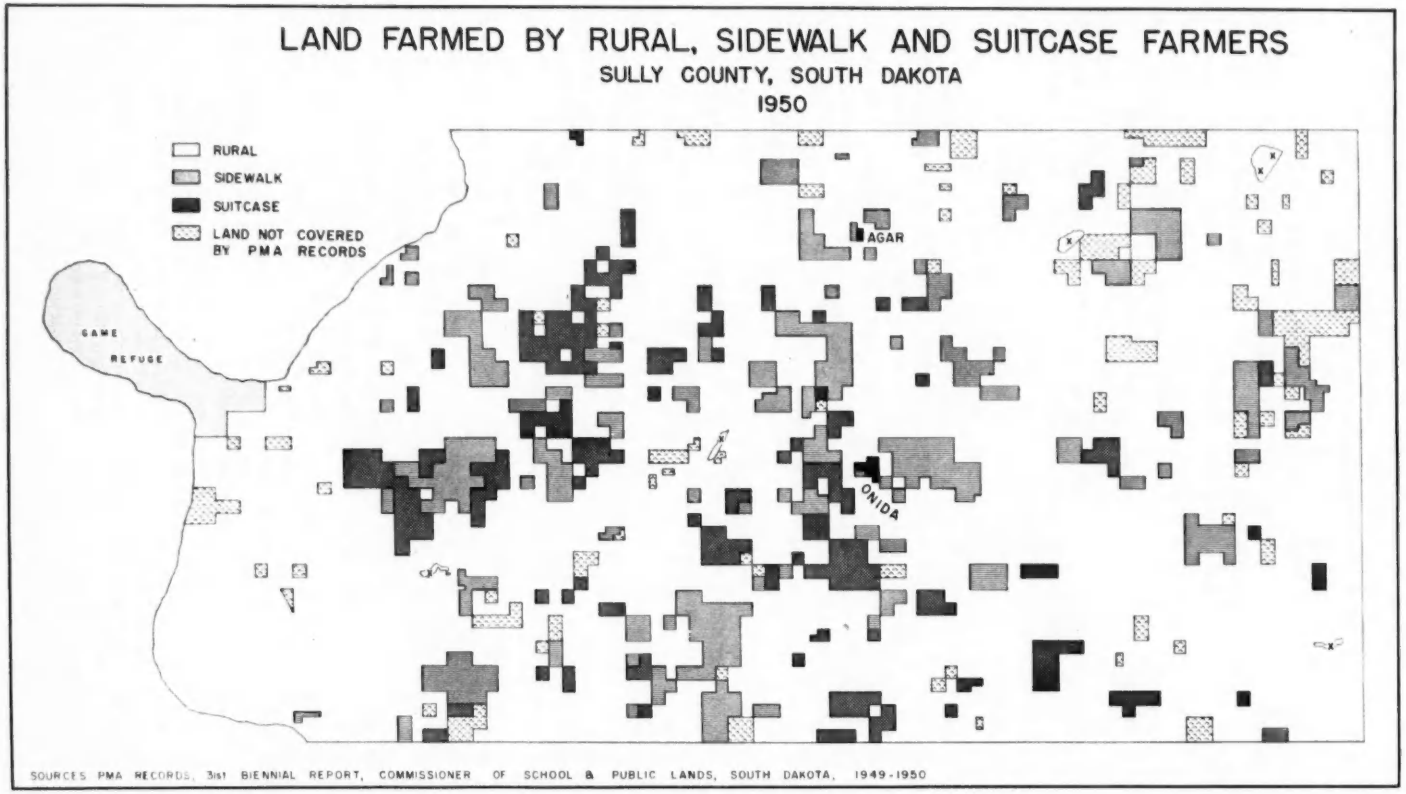

FIG. 1. In 1950 about 84 percent of the land covered by PMA records in Sully County was farmed by rural farmers, 9 percent by sidewalk farmers, and 7 percent by suitcase farmers. During that same year suitcase farmers represented nearly 11 percent of the total number of farmers in the county. By 1952 they represented about 15 percent of all farmers and farmed about one-third of the wheat land in the county.

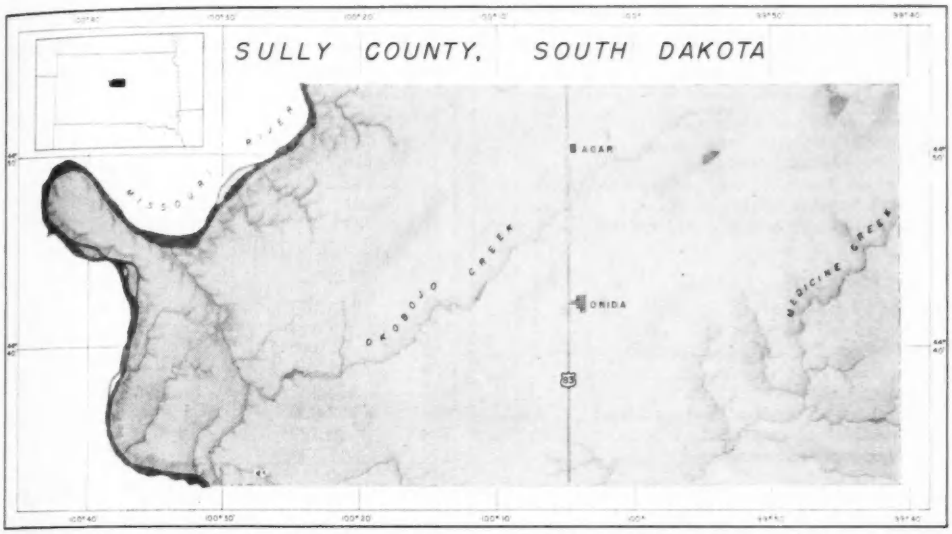

FIG. 2. Sully County borders the Missouri River in central South Dakota. The terrain in most of the county is remarkably flat. The most pronounced slopes are found near the Missouri River. Some dissection is also found along the lesser streams in the county.

these farmers, this compilation job was no simple task.

Of the 516 farm operators listed for Sully County in the 1950 PMA records, 418 (81 percent) lived on dispersed farmsteads (rural farmers), 44 (8.5 percent) lived in town (sidewalk farmers), and 54 (10.5 percent) lived more than 30 miles from the border of the county and so were classed as suitcase farmers (see Fig. 1). In the summer of 1952 there were 78 suitcase farmers and if it is assumed that the total number of farmers in the county remained unchanged since 1950, these operators represented 15 percent of the farmers in the county. According to PMA records, suitcase farmers were farming about a third of the wheat land in the county in 1952. Available evidence also shows that sidewalk farming in 1952 had not increased substantially over 1950. These unlike trends and developments helped to focus special attention on the suitcase farmers.

THE SETTING

Sully County lies somewhat north of the center of South Dakota and borders the Missouri River on the east (Fig. 2). In the northern part of South Dakota generally the Missouri River forms a rather sharp break between the flattish, glaciated croplands of the east and the dissected, non-glaciated grasslands of the west. Terrain and soil are the primary factors in this sharp break although decreasing precipitation also plays a part. In Sully County, average annual precipitation is about 16 inches, a figure which may suggest hazards to diversified crop farming and an emphasis on wheat farming.

Although Sully County lies in the part of South Dakota that is mostly farmed or cultivated, much of the county remains in grass, particularly in the western and eastern parts. In the west the lowlands along the Missouri River (to be flooded by Oahe Dam) and the associated breaks are in grass, and this sod extends several miles eastward onto the flat and rolling uplands. Here there are a number of very large ranches whose owners show more reluctance to plow possible cropland than do smaller operators, who usually engage in mixed farming. There is also much grassland in the eastern part of the county because of exposed glacial till material and slope problems. The cultivated lands in Sully County lie mostly in a central north–south belt—bordered by the grass areas mentioned above. This farm belt is flat to undulating and the soils are formed on a deep mantle of loess. The terrain is well suited to large-scale mechanized farming (Fig. 2).

TABLE 1.—SELECTED FARMING DATA FOR SULLY COUNTY, 1949–50 AND 1954[1]

Item	Census of 1950		Census of 1954	
Farms, number	478		419	
Approximate land area, acres	679,040		679,040	
Cropland harvested, acres	323,119		340,334	
Cropland not harvested and not pastured, acres	21,442		20,058	
Cultivated summer fallow, acres	4,761		16,954	
Other pasture—not cropland and not woodland, acres	289,767		280,113	
Crops:	Farms reporting	Acres	Farms reporting	Acres
Corn for all purposes	300	45,165	368	77,786
Sorghum for all purposes	101	3,699	70	3,438
Winter wheat	2	440	27	13,499
Durum wheat	9	1,783	5	605
Other spring wheat	417	135,597	365	84,905
Total wheat threshed and combined	428	137,820	397	99,009
Oats threshed and combined	208	9,339	326	26,903
Barley threshed and combined	174	11,336	93	6,401
Hay cut (nonlegumes)	348	100,118	—	110,058
Alfalfa	27	1,169	188	10,146
Livestock:		Number		Number
Horses, colts, ponies and mules	269	1,417	226	1,048
Cattle	368	33,077	350	50,439
Milk cows	355	15,424	245	1,065
Hogs	256	7,065	237	17,003
Sheep	64	16,419	76	39,599
Chickens	300	27,082	296	39,277

[1] Compiled from 1954 *Census of Agriculture.*

Land use and livestock data for Sully County as reported in the 1954 *Census of Agriculture* reflect a rather diversified farming program (see Table 1). For the year 1954 the farmers in the county reported 340,334 acres of cropland harvested and 280,113 acres in "other pasture," which is largely native grassland. It is this grassland which in large measure supports the numerous cattle in the county. Only about 17,000 acres of cultivated summer fallow land were reported.

Although grasslands predominate in the eastern and western parts of the county, pastures and cattle are also common in the central farming belt. As Table 1 shows, 350 of the 419 farms in the county reported cattle in 1954. Local or indigenous farmers here—aside from suitcase farmers—have a well-established tradition of diversification, as a hedge against drought hazards and price fluctuations. This diversification is now being challenged by the suitcase farmer.

The crop program in Sully County is far removed from a monoculture based on wheat. Reported data reflect a rather fluid farming program. While wheat is clearly the main crop—and certainly the main cash crop—corn acreage is surprisingly high (77,786 acres in 1954 but only 45,165 acres in 1949)[5] and the acres planted to oats, alfalfa, and barley are significant. Aside from the wheat acreage, the agricultural statistics for the county suggest at least a modified corn belt. This is particularly true when consideration is also given to the livestock figures (note the number of cattle, hogs, sheep, and chickens).

Many of the pioneers in western Kansas and Nebraska made a determined effort to extend the Corn Belt to the steppe lands on the Plains. Only after varying periods of time and many failures with both wheat and corn was the supremacy of wheat established. Pioneers in Sully County, on the other hand, planted more acreage to wheat than to corn, though the acreage of the latter was substantial. For example, for the year 1889, the farmers of the

[5] State agricultural figures for the county report almost 87,000 acres of corn for 1955, and wheat acreage declined from an all-time high of 154,450 acres in 1952 to 102,000 acres in 1955.

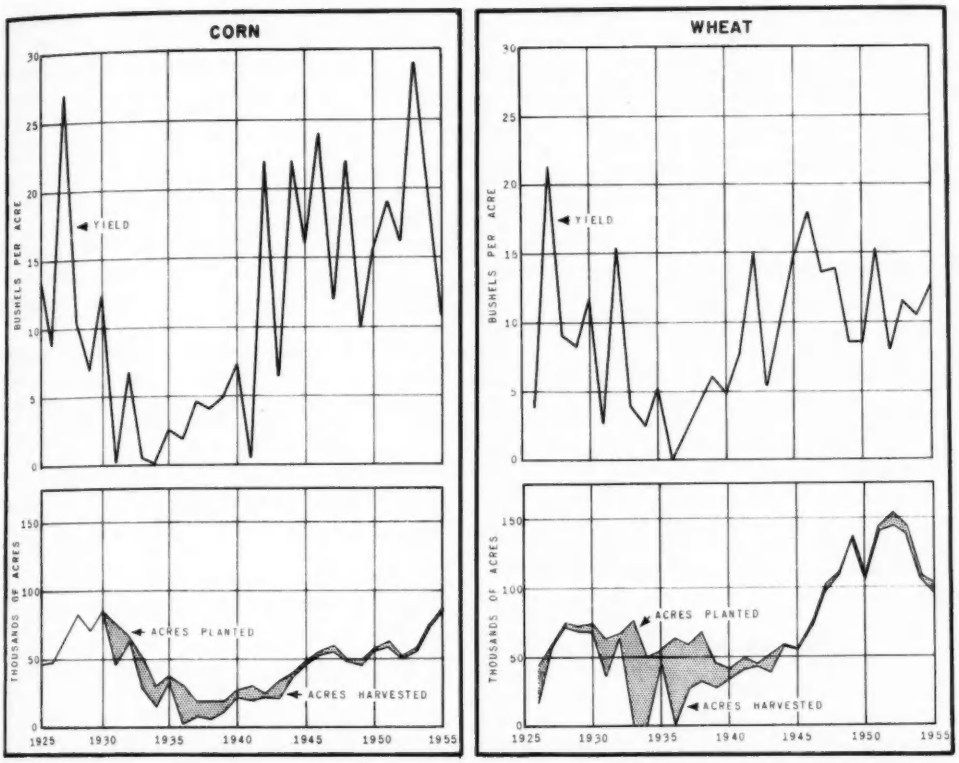

FIG. 3. Average yields of corn and wheat and acres of corn and wheat planted and harvested from 1925–26 through 1955 in Sully County. The low yields during the '30's are conspicuous as are the radical changes in yields during the '40's. Neither crop enjoys a clear advantage in terms of total yields or consistency of yields. Source: Data compiled from *South Dakota Agriculture*, annual report prepared by Crop and Livestock Reporting Service, a state–federal service.

county reported about 17,000 acres of wheat and 10,000 acres of corn. However, for 1919 and 1929 corn acreage slightly exceeded wheat acreage (17,493 to 16,789 and 71,039 to 68,216, respectively) and it was not until the early '30's that wheat acreage outstripped corn by a considerable margin.

In terms of yields, it cannot be demonstrated that wheat is a safer crop than corn in Sully County. For example, during the period from 1942 through 1955 the average yield of corn was 17 bushels per acre harvested and wheat was nearly 12 bushels. In part the price advantages of wheat were matched by a greater per acre yield of corn. Moreover, corn provides a greater amount of rough feed for cattle, even if the yield is low.

The yield records for wheat and corn in Sully County do not suggest that this area is very good for either wheat or corn. Average yields for long periods are modest, and fluctuations in yields from year to year and over periods of years vary greatly (see Fig. 3). From 1931 through 1941, for example, corn averaged less than 3 bushels per acre harvested and during four of these years less than 1 bushel was harvested per acre. During this same period wheat averaged about 5 bushels per acre. The emphasis given to both corn and wheat reflects a search for a land-use program that will provide the greatest security under prevailing climatic limitations. The modest and variable yields also help to explain the emphasis local farmers give to livestock, particularly beef cattle.

The continuing competitive role of corn in Sully County rests in part on climatic conditions. Sully County lies in the Spring Wheat

TABLE 2.—POPULATION OF SULLY COUNTY, SOUTH DAKOTA, 1880–1950[1]

Year	Rural	Onida	Agar	Total
1880	296	—	—	296
1890	2,412	—	—	2,412
1895	1,641	—	—	1,641
1900	1,715	—	—	1,715
1905				1,479
1910	2,143	319	—	2,462
1915				2,004
1920	2,376	455	—	2,831
1925				3,611
1930	3,016	636	200	3,852
1935				3,246
1940	1,929	597	142	2,668
1945				2,172
1950	1,750	822	141	2,713

[1] Compiled from U.S. census reports.

Belt of the Northern Plains where winter crops, such as winter wheat, were unthought of until a few years ago. All crops, including corn and wheat, need to be sustained by summer rains. With a summer cropping program there is little or no opportunity to use fall and winter rains to advance the wheat crop so that an early harvest is achieved before hot and dry periods in the summer. Hot and dry summers may and often do injure wheat almost as much as corn. Winter wheat, on the other hand, can take advantage of fall rains and fall growth, whereas corn must be planted in the warm season.

Population changes in Sully County reflect varied experiences that relate to climate, crop yields, farm prices, technology, and economic conditions generally. Land alienation programs brought the first major stampede of settlers during the 1880's. Drought, and failure to adjust to it, brought an exodus of people during the 1890's and up to 1905 (see Table 2). By 1910 the population was slightly above the 1890 mark but the dry years (Fig. 4) from 1910 through 1914 again resulted in an exodus of people. From 1915 to 1930 the population expanded, reaching 3,852 in the latter year. These years were marked by minor and major ups and downs in precipitation, in crop yields, and the agricultural depression of the '20's. Nonfarm opportunities were limited, particularly in a state so largely rural and agricultural as South Dakota. Population therefore backed up on the farm, although out-migration was also substantial. These trying years were followed by the very dry '30's (really from 1930 to 1941) and then the wet '40's. Population declined from the all-time high of 3,852 in 1930 to 2,172 in 1945. Moisture conditions improved after 1941, crop yields rose, and so did the population. In 1950 the county had a population of 2,713 of whom 1,750 lived in the open country. Sully County has only two towns of moderate size, the county seat of Onida, which has grown moderately (see Table 2) and Agar, which declined in population from 1930 to 1940 with little change by 1950. The county is strictly rural in terms of livelihood.

Although yearly precipitation may be and often is a misleading clue to crop yields—and population stability—some general relationships do exist, particularly in an area where average moisture supply is limited and variable. Long-time weather records are not available for Sully County, and so data for Pierre, South Dakota, a city about 45 miles southwest of the center of the county, were used to prepare Figure 4 on average yearly precipitation.

The figure shows two protracted dry cycles for the years 1909 through 1913 and 1930 through 1941. Both of these periods brought a series of crop failures and also marked declines in population. For many other years and periods average annual precipitation fluctuated rather sharply, as did crop yields. These ups and downs in yield and economic conditions have helped to create a local tradition of cautiousness which, in turn, is related to a tradition of diversified farming. It is this tradition of cautiousness and diversification

FIG. 4. Yearly percent of annual normal precipitation at Pierre, South Dakota, from 1892 to 1955. Pierre lies about 45 miles southwest from the center of Sully County. No long-time records are available for Sully County.

Source: Compiled from reports of United States Weather Bureau.

TABLE 3.—VALUE OF LAND AND BUILDINGS IN SULLY COUNTY, 1910–50[1]

Year	Total value	Value per acre
1910	$ 8,663,790	$ 26.80
1920	18,677,430	38.58
1925	10,554,905	30.67
1930	10,961,089	20.92
1935	6,144,388	12.09
1940	2,850,244	4.90
1945	3,813,623	6.09
1950	14,269,959	21.50
1954	22,909,244	33.86

[1] Compiled from U.S. census reports.

which is now being tested, or, should we say, violated by the suitcase farmers.

The changes in the economic climate of Sully County are shown in part by the changing values of land listed in census reports. Aside from the changing values of money, land values reached their peak in the county in 1920 when the average per-acre value reported was $38.58 (see Table 3). Then came the depression of the '20's and the drought–depression of the '30's which cut this average value down to $4.90 in 1940. The postwar years again brought a marked swing upwards and in 1954 the average value per acre of farmland was reported as $33.86. The apparently modest but rising land values since World War II also served to attract the attention of outside investors, including suitcase farmers. Good wheat land, even where fallowing is practiced regularly, frequently sells for as much as $100 and more per acre.

TABLE 4.—FARM MORTGAGE FORECLOSURES IN SULLY COUNTY, 1921–49[1]

Year	Number	Acreage	Year	Number	Acreage
1921	18	7,000	1936	43	8,173
1922	47	13,420	1937	25	6,693
1923	56	23,360	1938	37	13,676
1924	58	17,782	1939	7	2,360
1925	38	11,320	1940	5	1,448
1926	37	11,061	1941	1	6,264
1927	47	11,930	1942	4	480
1928	10	3,999	1943	4	560
1929	20	6,680	1944	5	1,380
1930	14	2,720	1945	2	640
1931	51	16,520	1946	2	1,760
1932	49	15,512	1947	1	320
1933	42	10,342	1948	0	0
1934	39	7,675	1949	0	0
1935	4	11,865			

[1] Compiled from Gabriel Lundy and Ray F. Pengra, *Farm Mortgage Foreclosures in South Dakota, 1921–49*, Revised Supplement to Circular 17 of May, 1934, South Dakota State College of Agriculture and Mechanic Arts, Brookings (December 1950), pp. 6–26.

Farm mortgage foreclosures also serve as an index to the economic health of a farming community. Table 4 shows these foreclosures for Sully County from 1921 to 1949. In some years in the '20's and '30's foreclosures approached 10 percent of the total number of farms. However, only in part do these foreclosures reflect drought conditions. Land value rose to excessive heights during World War I. Sales of $75 to $100 per acre were reported and much land was covered by high mortgages. The following years of economic stress brought foreclosures on much of the mortgaged land. With the beginning of the '40's this cycle had pretty well run its course and no protracted crisis has developed since that time.

DEVELOPMENT OF SUITCASE FARMING

The development of suitcase farming in Sully County rests on a complex of agricultural experiences and practices. Success and failures in crop production over a period of decades instilled a degree of cautiousness in local farmers and so diversification was practiced in both crops and livestock, although the latter meant that most emphasis was given to beef herds. Beef herds are largely supported by the native pastures, which vary in coverage, being most extensive in the western and eastern parts of the county, partly because of terrain and soil types. The flat and nearly flat grasslands on loessial soil in the central belt seemed an anomaly to outsiders and here is where the suitcase farmers saw their best opportunities. Purchase and lease of land meant, of course, that units taken over by suitcase farmers also included varying amounts of established crop lands. As Table 1 shows, Sully County farmers reported nearly 290,000 acres of "other pasture" in 1949 and 280,000 acres in 1954. This is almost entirely native pasture land. Note also the decrease in this type of land which was and is being converted to plow land.

Suitcase farming is a recent development in Sully County. Records and names in the PMA office revealed only 12 such operators in 1948. By 1952 their number had increased to 78, an

TABLE 5.—NUMBER OF SUITCASE FARMERS OPERATING FARMS IN SULLY COUNTY, 1948–52[1]

Year	Number of operators	Increase over previous year	
		Absolute	Percent
1948	12	—[2]	—[2]
1949	35	23	191.0
1950	54	19	54.2
1951	62	8	14.8
1952	78	16	25.8

[1] Based on data gathered from PMA card files and informants in the courthouse.
[2] Unknown.

increase of over 600 percent (see Table 5). Subsequent increases apparently have been less drastic but this is only an impression based on local opinion.

Partly because of the grazing operations in Sully County, farm units are relatively large. The agricultural census for 1954 shows average units of 1,587 acres. Data compiled from the PMA records in the county showed that for 1950 local operators farmed an average of 1,280 acres and suitcase operators 730 acres (see Table 6). Suitcase operators, however, may and do farm land elsewhere, largely in other states, and so the above operations are not complete.

Suitcase farmers are largely crop farmers as is shown in Table 6. Local farmers reported more pasture than cropland (720 vs. 514 acres) whereas suitcase farmers reported an average of 625 acres of cropland and 80 acres of pasture. Their main interest is in wheat farming.

Table 7 shows how suitcase farmers concentrate on wheat farming whereas local farmers practice a much more diversified program of farming. For 1950, 53 out of 54 suitcase farmers (almost 100 percent) reported wheat but only 88 percent of the local farmers raised this crop. Moreover, suitcase farmers planted about two-thirds of their cropland to wheat (67.5 percent) whereas local farmers planted about a third to this crop (34.0 percent). For feed crops the situation is in reverse. Local farmers devoted about 61 percent of their cropland to feed crops whereas for suitcase farmers this acreage came to about 25 percent. These figures show quite clearly that diversified crop and livestock farming is a well-established practice among local farmers in Sully County and it is this practice, based partly on grassland, that is altered radically by the new type of operator.

Suitcase farmers must be mobile and many of them cover long distances in their farm

TABLE 7.—LAND USE BY CROPS AND TYPE OF OPERATOR, SULLY COUNTY, 1950[1]

Crop	Suitcase farmer			Local farmer		
	Number of farms	Acres per farm	Percent of cropland	Number of farms	Acres per farm	Percent of cropland
All cropland	54	625	100.0	462	514	100.0
Cash crops:						
Wheat	53	428	67.5	406	199	34.0
Flax	6	109	2.0	33	122	1.7
Total			69.5			35.7
Feed crops:						
Corn	9	133	3.6	363	151	23.1
Barley	16	231	10.9	283	93	11.1
Oats	5	83	1.2	305	62	8.5
Rye	7	267	5.6	90	113	4.3
Sorghums	8	68	1.6	184	53	4.1
Minor grains	1	255	0.8	39	26	0.5
Tame hay	11	43	1.1	348	64	9.3
Total			24.8			60.9
Fallow land	6	233	4.2	26	120	1.3
Idle land	19	26	1.5	128	38	2.1

[1] Compiled from PMA records.

TABLE 6.—LAND USE BY SUITCASE AND LOCAL OPERATORS, SULLY COUNTY, 1950[1]

Land use	Suitcase operator			Local operator		
	Acres operated	Percent of county total	Average acreage of operation	Acres operated	Percent of county total	Average acreage of operation
Total farmland	39,413	6.3	730	590,845	93.7	1,280
Cropland	33,767	12.8	625	237,472	87.2	514
Pasture	4,331	1.3	80	332,774	98.7	720
Other land[2]	1,315	5.9	24	20,599	94.1	45

[1] Computed from card files of the PMA office, Sully County, 1950.
[2] Roads, ditches, lakes, etc.

TABLE 8.—RESIDENCE OF SUITCASE FARMERS, BY STATE AND COUNTRY, 1952[1]

Residence	Number	Residence	Number
Texas	20	Nebraska	3
Oklahoma	17	Canada	2
Kansas	16	Iowa	1
South Dakota	6	New Mexico	1
Minnesota	5	Unknown	2
Colorado	5		

[1] Compiled from card files of the PMA office and the plat books of the Register of Deeds office, Sully County, 1952.

operations. Of the 76 suitcase farmers whose place of residence was established, nearly 70 percent lived in Texas, Oklahoma, or Kansas (Table 8). Other suitcase farmers from the "south" lived in Nebraska, Colorado, or New Mexico and some in southern South Dakota. In all about 85 percent of these operators moved in from the south. The south–north operational pattern of these suitcase farmers immediately brings to mind the northward movement of wheat harvesting crews and also the northward advancing season of planting and harvesting. If wheat harvesting equipment can be moved northward to follow the harvest why can't plowing and seeding equipment follow a like itinerary? Many informants pointed out that suitcase farming is an offspring of migratory harvesting crews. It was also pointed out that "big money" is behind the suitcase farmers, such as "oil money" or bonanzas based on large wheat and/or cattle operations during World War II. Little information was gathered directly from the shifting suitcase farmers and so no positive statements should be ventured other than that some harvesting crews did report that suitcase farming was possible and profitable—at least during some years.

TECHNIQUES AND METHODS OF FARMING

Although Sully County lies in one of the major spring wheat belts of the northern Plains, suitcase farmers concentrate largely on winter wheat production. Informants in Sully County pointed out that winter wheat had been tried by local farmers over the years but did not prove a dependable crop. Nevertheless, suitcase farmers plant this crop on almost all their wheat acreage and their success is being noted by local farmers, many of whom are also shifting to fall planting. Why this change? At first successful winter wheat harvests were laid to good luck, resulting largely from proper winter conditions which did not kill the crop. However, a series of good winter wheat harvests raised doubts about this explanation.

As was pointed out, the majority of suitcase farmers in Sully County domicile somewhere in the Winter Wheat Belt of Texas, Oklahoma, and Kansas. A good many of them also raise wheat in or near their home state and little spring wheat is grown south of South Dakota. This familiarity with winter wheat may explain in part the emphasis given by suitcase farmers to winter wheat production in Sully County. However, their emphasis on winter wheat rests also on other grounds.

Winter wheat, where it doesn't winter kill, generally out-yields spring wheat. During very recent years, some extraordinarily good yields have been obtained from this crop in Sully County. For example, a suitcase farmer from Kansas harvested 4,000 acres of winter wheat in the summer of 1953 which yielded 41 bushels per acre. Spring wheat, on the other hand, was considered good if it yielded 20 to 30 bushels per acre. On the basis of only a few years of experience, informants in Sully County reported that winter wheat out-yields spring wheat by about 25 percent. This advantage may be overestimated and may narrow over a longer test period. Nevertheless, the recent success that has marked winter wheat production in Sully County is exciting much comment, some envy, and some criticism. Some local farmers are impressed with the results and are beginning to venture plantings of the crop.

Suitcase farmers also cite other advantages in growing winter wheat. Winter wheat makes some growth in the fall, and partly for this reason ripens earlier and can be cut earlier than spring wheat. This also means that the stubble can be plowed earlier preparatory to early fall planting of the next crop. At least in part these early operations avoid the hazards of summer droughts and summer hail. Although Sully County receives most of its moisture in the summer, rainfall is always uncertain and less effective when temperatures reach their maximum. Even when the moisture supply is limited in the spring, the wheat plant survives and waits for rain. A good stand of winter wheat is therefore ex-

pected to do as well as spring wheat and to do a good deal better if early rains arrive.

Since winter wheat is expected to mature earlier than spring wheat, a combination of these crops in the same county lengthens the harvesting period. A longer harvesting period benefits custom harvesters and many of the suitcase farmers do custom work for others. During the summer of 1953, many of the suitcase farmers first harvested their winter wheat and then contracted to cut spring wheat for local farmers. This sort of opportunity will be present only so long as the two types of wheat are grown in the county. Some of the suitcase farmers also pointed out that an early harvest means that local elevators are empty and so there is no problem of finding storage for the harvested grain.

Suitcase farmers are introducing harvesting methods that are common in the Winter Wheat Belt. In this belt the self-propelled combine is commonly used to cut and thresh the grain in one operation. This dual operation is expedient because small grains are usually well ripened by hot dry winds and the moisture content of the harvested wheat is usually low enough so that it can be stored in elevators or sheds. In wet years, however, the moisture content is so high that enclosed storage is hazardous. This means that the harvested grain needs to dry or be dried. A common practice is to dump the wheat on the open ground for a period and if necessary to repile it one or more times. Sun and air then lower the moisture content of the wheat. Mechanical dryers are also available in some places to dry the wheat promptly. When a safe moisture content has been achieved, the wheat is placed in sheltered storage, usually elevators. This method of cutting, threshing, and drying of wheat is generally used by the suitcase farmers operating in Sully County.

Most of the local farmers in Sully County still use a method of harvesting wheat that is common in Minnesota and in the eastern parts of South Dakota and North Dakota. This method provides for the swathing of the wheat stalks with grain. A device known as a "swather" cuts the wheat stalks and piles them in a continuous windrow. These windrows are left on the ground for several days or more until the grain dries to a safe point for storage. These dried windrows of cut grain are then threshed with a combine with a reel pick-up attachment or with a side-scoop combine. Usually these implements are smaller and cheaper than the large self-propelled combines seen in the Winter Wheat Belt and in other more westerly wheat growing areas. It should be noted that this method calls for two separate field operations, an arrangement which complicates procedures for suitcase farmers, who like to keep on the move. However, a suitcase farmer who needs to pile and repile his drying grain on the ground also loses some time in waiting or making a return trip. The use of the self-propelled combine by suitcase farmers for cutting and threshing in one operation does save some time, energy, and money in that no second implement, a swather, needs to be bought and hauled around.

Established plowing methods in Sully County are also being challenged by suitcase farmers. Until the suitcase farmers arrived, the multiple moldboard plow was standard equipment on farms. Wheat farmers in the Winter Wheat Belt abandoned the moldboard plow from one to several decades ago and usually use the disk plow, also called the one-way. It is this disk plow or one-way that the suitcase farmers in Sully County are using almost exclusively. Disk plows can be hitched in tandem and it is not uncommon to pull two or three of these plows with a large tractor, perhaps crawler-type tractors. This means that each move across the field turns a path or strip about 45 feet wide. This method, of course, covers a field much faster than a two- or three-bottom moldboard plow. Use of the disk plow by suitcase farmers may rest partly on its efficiency, but these farmers own and operate these plows in the southern Plains and so it seems logical to transport their equipment to Sully County and use it if it appears to do the job.

Like other innovations brought by the suitcase farmers, the disk plow raises its share of apprehension and criticism. Its speed of performance is admitted. Moreover, it will cut and turn heavy stubble that may clog a moldboard plow. It was claimed, however, that the disk plow cuts the soil too fine during dry periods and so predisposes the field to blowing (dust storms). Moldboard plows form more distinct ridges than disk plows, and also leave a coarse texture of lumps of soil at the surface. Both conditions serve to anchor the soil against blowing during dry periods. No

long dry spells have been experienced lately and so blowing soil material has not presented a serious problem. In the absence of such a crisis the controversy remains unresolved.

WHY SUITCASE FARMING?

It is easier to describe and analyze some of the activities of the suitcase farmer in Sully County than to present definite reasons for his growing role in the agricultural activities of that county. During the eight weeks' period when field work was carried on in the county in the summer of 1953, very little information could be obtained directly from these operators. They or their help come to the county for only short periods and even then they are hard to find. There is no popular hotel in the county where one might expect to find them. Lodging is achieved in all sorts of ways and is found in all sorts of places, in or near the county. Some use trailers and appear and disappear like migratory birds.

Why then did the suitcase farmer come to Sully County and what are the prospects that lie ahead? Local informants were always ready to discuss these questions but their answers, while interesting, were not particularly helpful. As the reader might surmise, suitcase farming is not welcomed by local farmers and other citizens.

Many local informants associated suitcase farming with the brisk sales of farm lands during and after World War II. Special emphasis was given to the considerable amount of state and county land that was sold during this period and which, it was claimed, was bought by outsiders. An effort was made to check this claim by listing the number and type of land transfers from 1943 to 1952. Table 9 lists the number of land transfers made by the state, the county, individuals, and corporations during the above period. Much state land was sold from 1943 to 1948. Most of the county transfers were also made during this period. We find, however, by comparing Table 9 with Table 5, that most of the suitcase farming in the county developed after 1948. Apparently, suitcase farmers purchased most of their land from individuals and corporations.

TABLE 9.—NUMBER OF LAND TRANSFERS IN SULLY COUNTY, 1943–52[1]

Year	Seller				
	State	County	Individual	Corporation	Total
1943	46	15	54	21	136
1944	38	7	73	23	141
1945	5	5	88	37	135
1946	22	18	138	44	222
1947	11	17	159	20	217
1948	18	3	156	8	185
1949	1	1	103	13	118
1950	0	3	71	3	77
1951	0	1	74	7	82
1952	0	0	73	2	77

[1] Computed from the records of the Register of Deeds, Sully County. The table includes resales (the transfer of the same tract within a short period of time).

Some informants believed that much of the land in the county is absentee owned and that this situation opens the door to suitcase farming. Ownership records were therefore carefully examined to establish extent of absentee ownership (see Fig. 5). In 1950 about 13 percent of the land in the county was absentee owned (70,620 acres), a ratio not uncommon for many farming areas. During that same year, 54 suitcase farmers were farming 39,413 acres of which 79 percent was absentee owned —largely owned by them—and 21 percent locally owned. For the most part, suitcase farmers must either buy land or find absentee owners from whom to rent. It is not popular in the county to rent land to suitcase farmers. By way of contrast, local farmers rent only about 9 percent of their land from absentee owners. Absentee ownership—largely by suitcase farmers themselves—and suitcase farming do seem to be closely related.

Absentee ownership of land is not as common in Sully County as it is in many other dry-land wheat farming counties.[6] As was stated above, only 13 percent of the land in the county was owned by nonresident owners in 1950. Most of these absentee owners live in the Corn Belt (including cities) as is shown in Fig. 6, but this area furnishes few, if any, of the suitcase farmers (see Table 8). However, next to the Corn Belt, the Winter Wheat Belt domiciles the greatest number of absentee owners and is also the main source area of suitcase farmers. Rather striking is the fact that few absentee owners in Sully County live northward from that county (Fig. 6).

[6] For example, in Morton County, Kansas (southwest corner of the state), about 50 percent of the nonfederal land is absentee owned. In Sherman County, Kansas (bordering Colorado in northwest Kansas), about one-third is absentee owned.

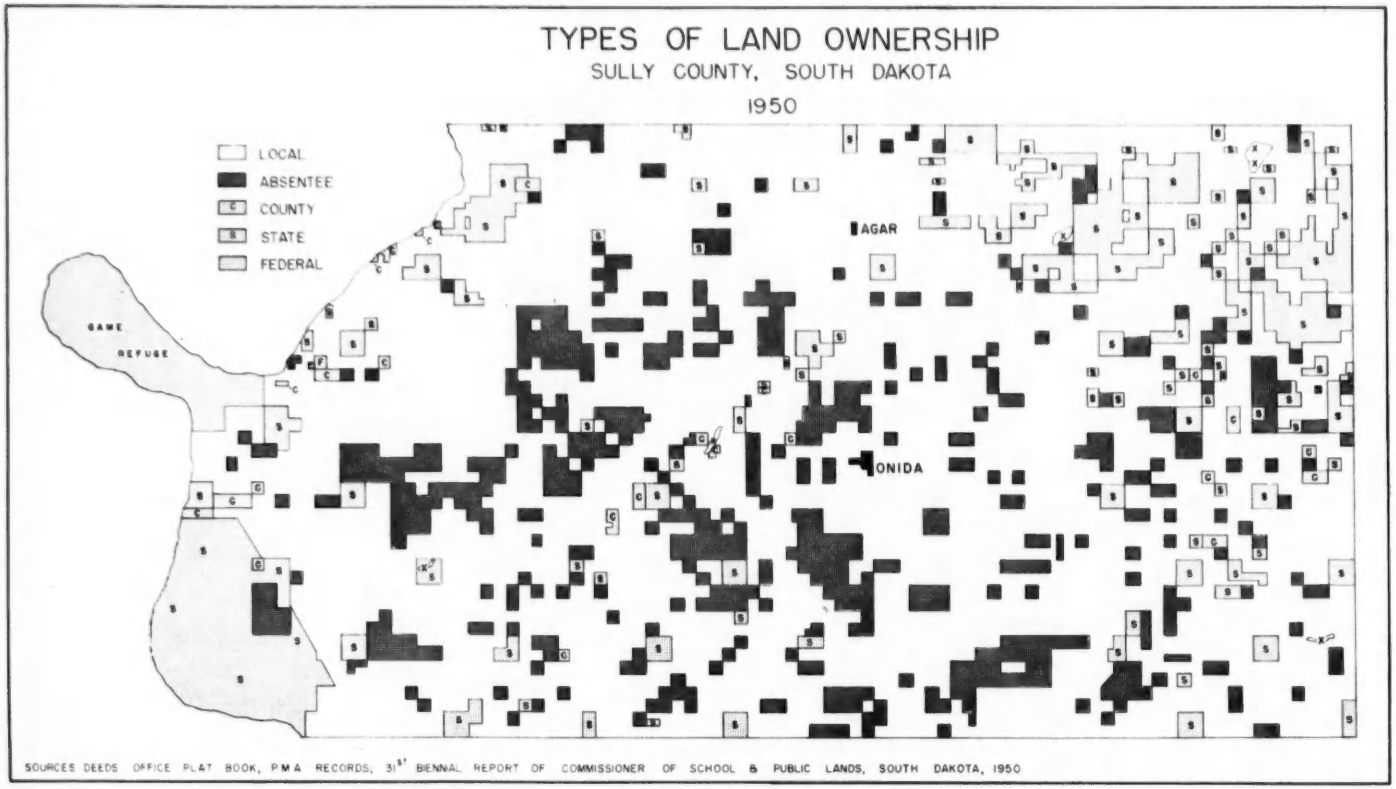

FIG. 5. In 1950 nearly 70 percent of the land in Sully County was privately owned by local owners. Slightly over 13 percent was absentee owned and about 12 percent was owned by the State of South Dakota. A federal game refuge covered nearly 2.5 percent of the land, and county owned land was slightly below 1 percent. The better farming lands lie in a north–south belt across the central part of the county.

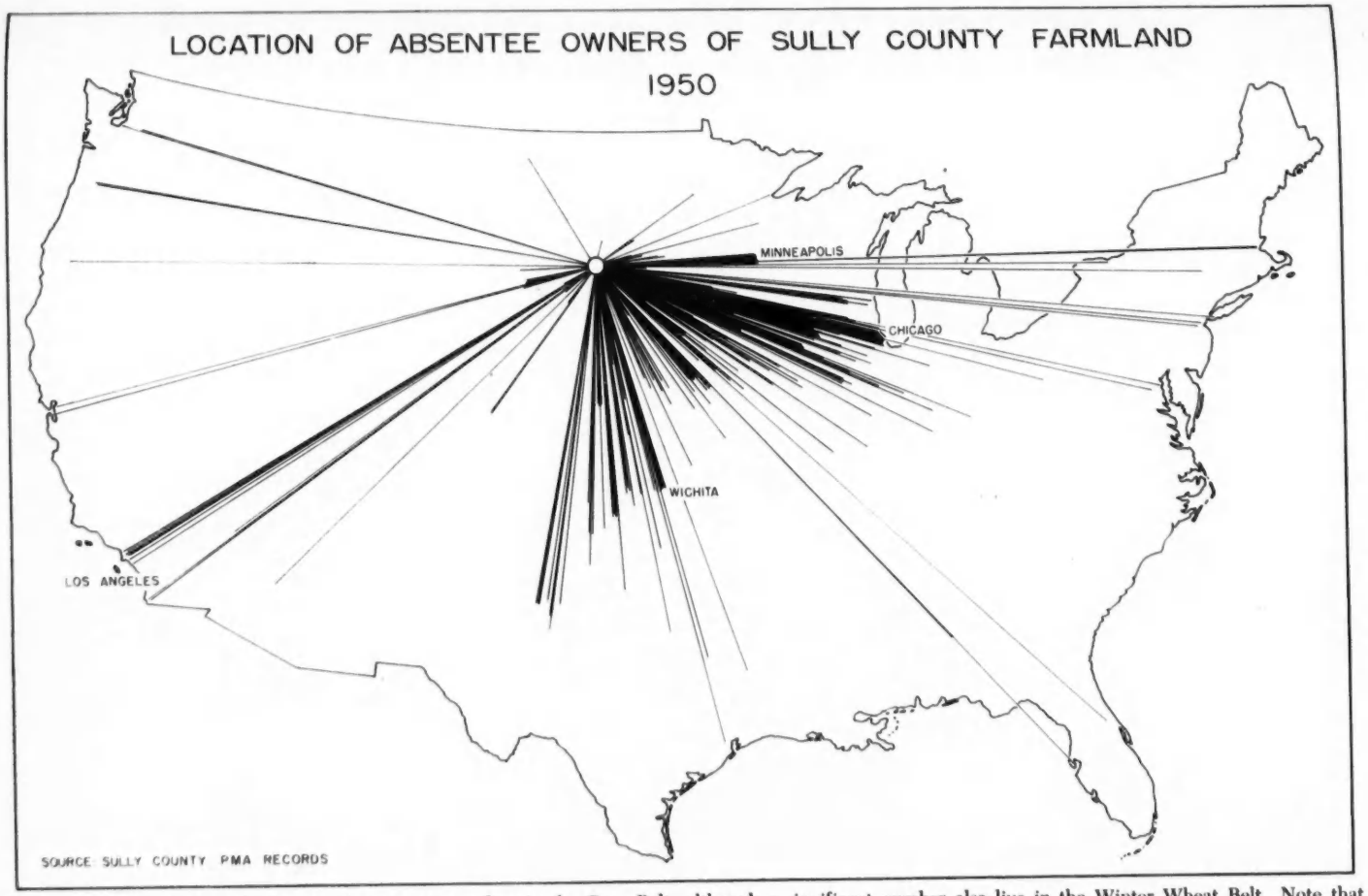

FIG. 6. Most of the Sully County absentee owners live in the Corn Belt, although a significant number also live in the Winter Wheat Belt. Note that few of these owners live north of the county.

The location of Sully County apparently helped the growth of suitcase farming. Western South Dakota and northwestern Nebraska (largely Sandhills) are mostly grass country. The grasslands are bordered on the north, east, and south by the Winter and Spring Wheat Belts. Harvesting crews moving northward from the Winter Wheat Belt to the Spring Wheat Belt will have more and better harvesting opportunities if they follow the harvest east of the Missouri River in South Dakota. Sully County lies at the western edge of crop farming in South Dakota (in its latitude) and U. S. Highway 83 (north–south) bisects the county near the center. This road is covered with harvesting crews moving northward seasonally. Many of these outfits are owned by winter wheat farmers who are interested in expanding their operations. They already own the necessary machinery and can cover more land, particularly in a geographic setting where the seasons of operations advance northward. From the standpoint of machinery investment, the program makes sense in that costly implements are put to a longer period of use each year. What is needed is more land in the right places, selling for prices that are attractive.

Harvesting crews coming to and passing through Sully County no doubt noted the great amount of land that is still in native grass. Much of this grass grows on a deep loessial soil and the terrain is nearly flat. Here is the sort of land that can well excite an ambitious wheat farmer. Add to this complex moderate but rising land prices and a few successful wheat crops, and the stage is set for investors. The suitcase farmer responded merely to what seemed an inviting economic opportunity, even though his method of farming was not orthodox.

It can be pointed out that the economic opportunities exploited by the suitcase farmer were likewise opportunities that the local farmer failed to exploit. For example, why hasn't the local farmer plowed more of the grassland and expanded his wheat operations? Also, why does the local farmer diversify his farming and plant a good deal of corn and also keep a variety of livestock? Local informants say that experience has shown the wisdom of diversification and that it is essential for survival. Agricultural specialists support and encourage this program of diversification. Local farmers and agricultural specialists are therefore in agreement and point out that local practices reflect experience that reaches back more than half a century. The suitcase farmer, on the other hand, is a newcomer and is an economic opportunist. He may or may not believe that conditions have changed since the "olden days" but he is ready to venture capital and time in an enterprise that has yielded good returns often enough to be attractive.

While local farmers mitigate farming risks by diversifying their agricultural operations, suitcase farmers hope to and do achieve the same objective by scattering their operations along a south–north axis which may reach across several states. The spotty nature of precipitation and particularly summer rainfall is well known. Even within a county, variations in crop yields can be traced to variations in local rainfall at critical times. Wheat fields spaced over larger areas or even several states are not likely to produce or fail in accord or in like measure. Prospects of harvesting at least some good fields are enhanced by multiplying chances over a large geographic area. During recent years we heard much about a major drought in the Southwest. This drought did not cover the Dakotas where some good harvests were realized. Suitcase farmers with operations stretching from the Winter Wheat Belt to the Spring Wheat Belt therefore must have fared better than local operators in the former belt. In other words, suitcase farming is a type of adaptation that meets at least in part a serious problem in Plains farming where wet and dry spells are to be expected.

MATADI, FOCUS OF BELGIAN AFRICAN TRANSPORT[1]

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THE port of Matadi, 80 miles up the estuary of the Congo River, is the sole ocean terminal of importance in Belgian Africa. Boma, on the northern shore of the estuary, serves only the Mayumbe area, accounting for less than six percent of the total volume of Belgian African trade. Banana, which faces the Atlantic on the right bank of the Congo mouth, has lost its earlier importance as a commercial port, though it has recently acquired some significance as a naval base and fishing haven.

In recent years Belgian Africa[2] has ranged between second and fourth place among sub-Saharan countries in value of exports and from second to third in imports. In 1955, Belgian African exports and re-exports totalled 1,398,000 metric tons valued at $466 million; imports were 1,706,000 metric tons valued at $378 million.[3] The qualitative or the strategic importance of Congo exports far outweighs the quantitative figures, however, for the Congo occupies an outstanding place in world exports of cobalt and industrial diamonds, and is among the leading producers of uranium, copper, manganese, tin, and zinc. In agricultural commodities, the Congo is one of the major world suppliers of oil palm products, and also exports some coffee, cotton, rubber, and other tropical crops. Congo imports comprise a wide range of consumer goods, fuels, and capital equipment destined to outfit the area with modern processing and forwarding apparatus.

The rapidly expanding economy of the Congo has been widely publicized and has made a substantial contribution to Belgium's unprecedented postwar prosperity. Belgium, in turn, has invested heavily in Belgian Africa, eighty times its size. And the possession by Belgium of only two contiguous overseas areas has permitted a concentration of manpower and resources that is in contrast with the position of other metropolitan powers with responsibility for scattered dependencies.

MATADI, THE OCEAN GATEWAY

Matadi, the most important gateway of Belgian Africa (Table 1), is situated in the narrow land corridor on the west which gives the almost landlocked territory a window on the Atlantic Ocean. One of the freak political boundary situations of Africa, fixed at the time of the Berlin Conference (1884–85), exists in this area. Only the northern bank of the lower navigable Congo belongs to Belgium and the width of Belgian territory there is further restricted on the ocean front by the Portuguese enclave of Cabinda and by French Equatorial Africa inland. Almost all of the south bank of the lower Congo is in Angola.

In their search for an effective national outlet which would be accessible to ocean-going vessels and capable of being tied easily by rail with the rest of Belgian Africa over their own soil, the Belgians had no other choice than Matadi's site. Its position was fixed by the last of the series of thirty-two rapids which preclude navigation between the maritime span of the Congo and Stanley Pool. This site, as will be seen, has numerous deficiencies both from the standpoint of navigational approaches and from the standpoint of port construction. Yet the establishment of any other ocean head down the estuary would have involved either bridging the Congo near Matadi or running a rail line through French territory and bridging the river at Stanley Pool.

The immediate hinterland of Matadi is extremely restricted. The great trade of the port is derived from the areas lying beyond the rapids. All these facts explain why Matadi, administratively and functionally, is merely a

[1] This article is the sixth in a series on various aspects of land and sea transportation in the middle belt of Africa prepared under a Columbia University contract with the Office of Naval Research, Geography Branch. The cooperation of a number of organizations and many individuals in the United States, Europe, and Africa is gratefully acknowledged.

[2] Consisting of Belgian Congo and the U.N. Trust Territory of Ruanda-Urundi. Unless otherwise noted, data apply to the whole area.

[3] See Belgium, Ministère des Colonies, Direction des Études Économiques, *La Situation Économique du Congo Belge et du Ruanda-Urundi in 1955* (Brussels, 1956), pp. 321–85. For a useful review of Congo's position in world trade see D. Gaignaux and A. Scohy, *Le Rayonnement Économique du Congo Belge*, Cahiers Belges et Congolais, No. 15 (Brussels, 1951).

TABLE 1.—DISTRIBUTION OF BELGIAN AFRICAN TRADE BY GATEWAYS, 1938, 1950, 1955[1]
(Percent of volume or value)

Gateway	1938		1950		1955			
	Volume		Volume		Volume		Value	
	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
Boma	3.0	13.1	2.0	11.4	2.2	9.0	1.4	2.4
Matadi[2]	53.1	65.2	61.0	55.4	67.4	48.4	65.4	50.1
Lobito	8.2	8.5	8.2	18.5	10.2	28.7	18.0	18.6
Beira	n.a.[3]	n.a.	0.1	7.0	0.1	6.2	0.5	11.0
Dar es Salaam	1.3	2.6	3.5	1.7	2.8	1.7	5.1	4.4
Mombasa	n.a.	n.a.	1.7	0.5	0.4	0.3	0.5	0.9
Port Elizabeth	n.a.	n.a.	under 0.1	—	0.1	—	0.6	—
Durban	n.a.	n.a.	under 0.1	—	under 0.1	—	under 0.1	—
Pointe Noire	n.a.	n.a.	—	—	under 0.1	1.5	under 0.1	3.3
Airports[4]	n.a.	n.a.	23.3	5.5	0.3	0.7	1.9	6.7
Rail or road frontier points[5]	n.a.	n.a.			16.3	3.5	6.6	2.6
Total	100	100	100	100	100	100	100	100

[1] Sources: 1938 and 1950—Supplied by Section Statistique, Gouvernement Général, Leopoldville; 1955—Belgian Congo, Conseil du Gouvernement Général, *Discours du Gouverneur Général—Statistiques 1955* (Leopoldville, 1956), p. XXXVII.

[2] Inclusive of Ango Ango.

[3] n.a.—not available.

[4] Largely in inter-continental traffic; some in inter-African exchanges.

[5] Traffic representing commercial interchange with adjacent African territories (French Equatorial Africa, Angola, British Central Africa, British East Africa, Sudan) or Union of South Africa via the Rhodesias.

transshipment point strictly dependent on the C.F.M.L. (*Chemin de Fer de Matadi à Léopoldville*). Leopoldville, the inland terminus of the C.F.M.L. and the head of interior river navigation, is, however, much more than a transfer point. The political capital of the Belgian Congo, it is also its most important commercial and manufacturing city. So closely connected are the transport functions of the Matadi–Leopoldville seaport–rail–river port system that the Belgian State has placed them under the single quasi-governmental "Otraco" (*Office d'Exploitation des Transports Coloniaux*), one of the four leading transport organizations in Belgian Africa.

Approaches to the Port

The inland location of Matadi (Fig. 1A), comparable to that of Antwerp or Hamburg, confers some benefits on Congo's trade by reducing the distance and hence the costs of land transport to and from the interior. Matadi is the only ocean terminal of central and southern Africa located so far inland. On the debit side are the impediments to navigation encountered by deep-sea shipping calling at the terminal. A constant and costly effort is required to improve and maintain the maritime span of the river.

Between Malela and Boma, the middle section of the lower Congo is choked with unstable sandbanks, accumulation of silt, and sand islands.[4] The main channel through this section was deepened between 1927 and 1955 from 19 to 30 feet, but it is necessary to dredge two million cubic meters of sediment annually to maintain that depth. After intensive surveys of innumerable swampy creeks and changing passes a greatly improved system of channel marking has been installed, including luminous buoys to permit night navigation under pilotage. Before 1955 it was necessary to wait for daylight before traversing the lower Congo, which sometimes resulted in delays of as much as two days on the combined inward and outward ship voyage. Incoming vessels have still to contend, however, with powerful currents at the entrance of the estuary, sharp turnings in the constricted rocky passage below the port, and notorious whirlpools at the Devil's Cauldron (*Chaudron d'Enfer*).

[4] See E. J. Devroey and R. Vanderlinden, *Le Bas Congo, Artère Vitale de Notre Colonie* (Brussels, Goemaere, 1951), pp. 27–141.

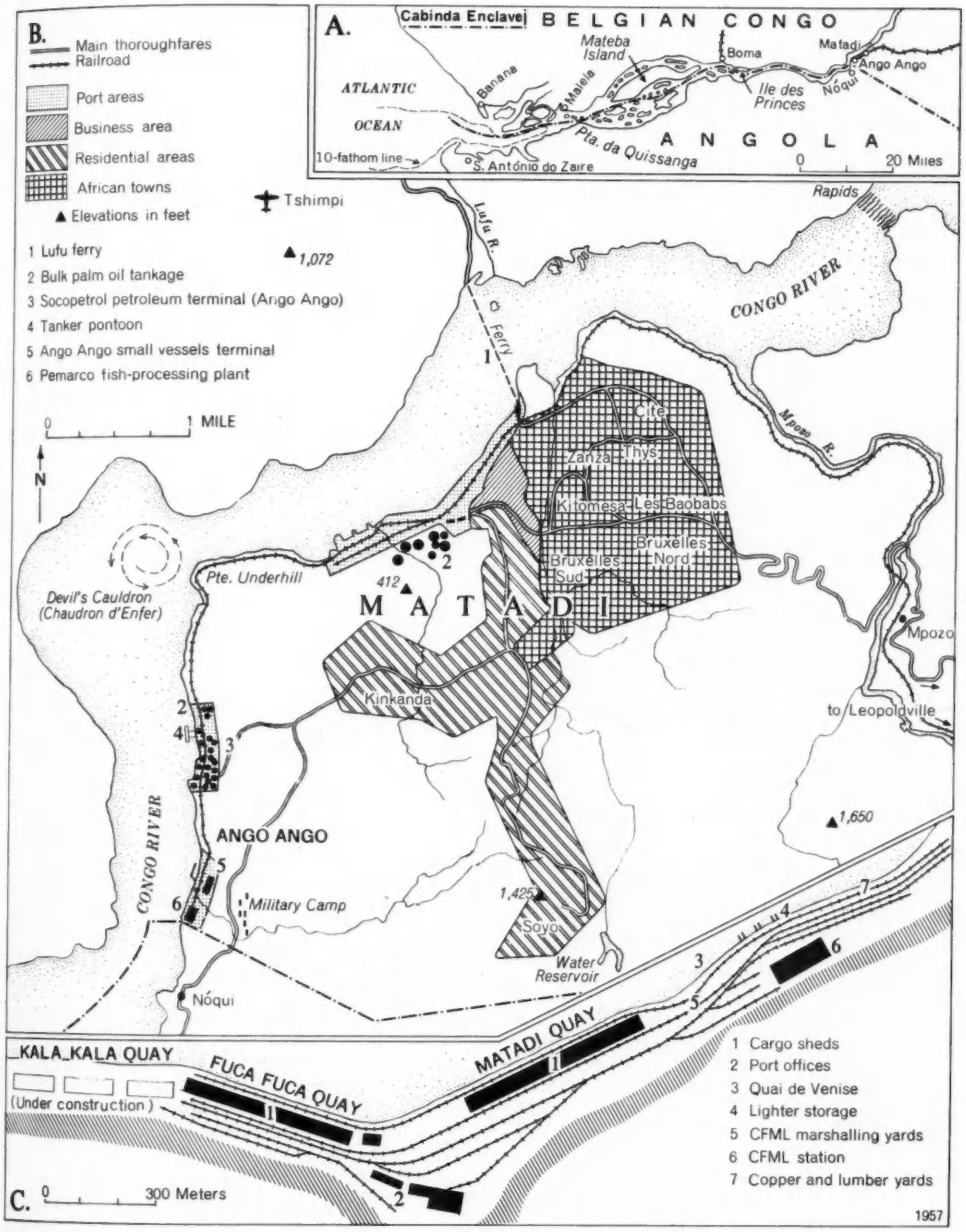

FIGURE 1

(A) Upper inset: Navigational approaches to the port on the maritime span of the Congo River.
(B) Main map: Port terminals and city of Matadi.
(C) Lower inset: Plan of the main port area.

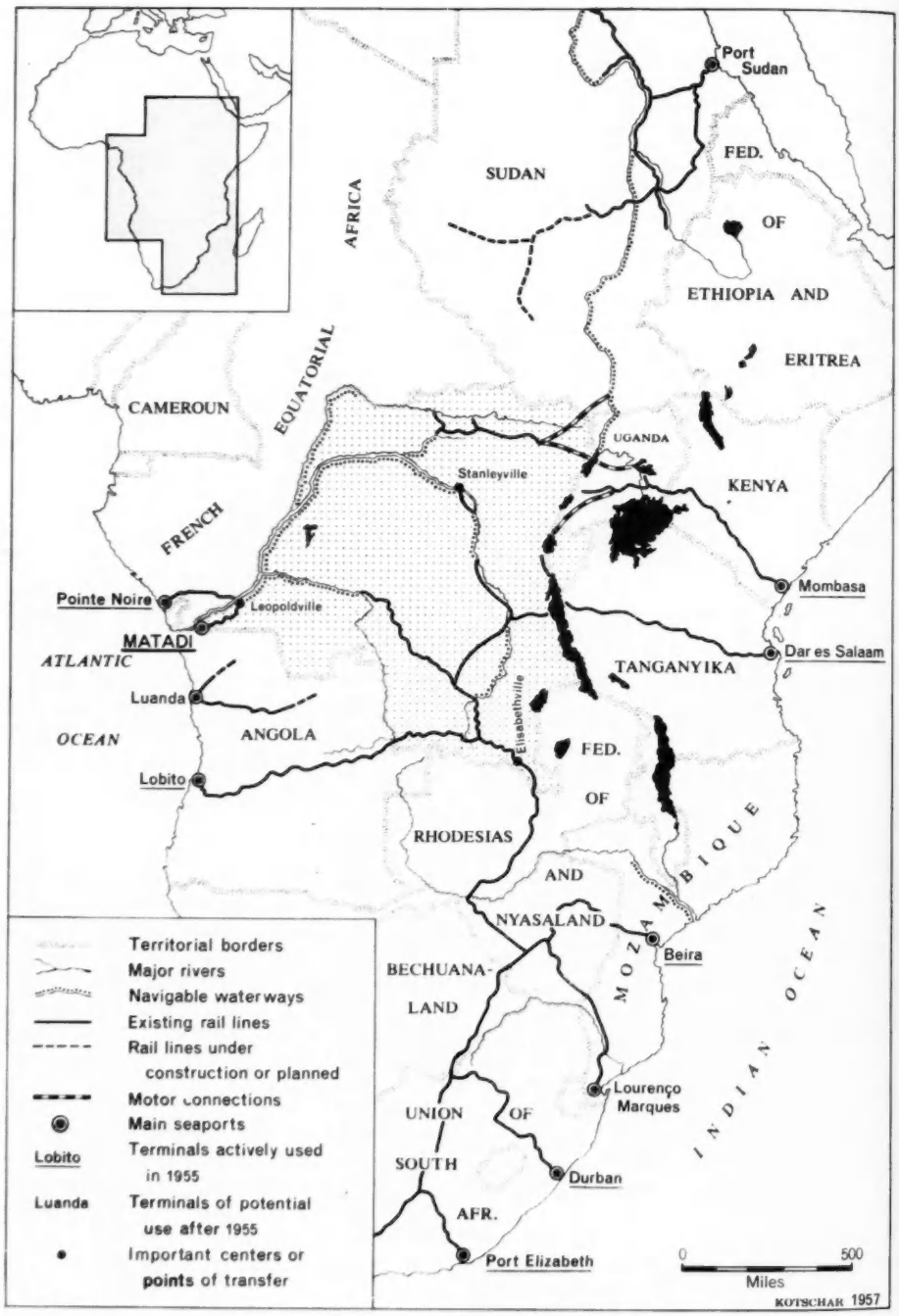

FIG. 2. Actual and potential gateways to Belgian Africa.

The Port

A rudimentary metal pier was available at Matadi as early as 1890, but berthing accommodations suitable for deep-sea vessels were not completed until 1933. Port traffic, inclusive of Ango Ango, the outport, grew from 530,567 metric tons in 1938 to 1,827,058 tons in 1955. The increase in cargo handled was particularly strong after 1946 and led to acute congestion in several years, resulting in the imposition by shipping companies between 1948 and 1951 of maritime freight surcharges of up to 30 percent on goods booked for Matadi. The port was not solely responsible for the difficulties, for there was a second bottleneck at Leopoldville. However, even with a sustained increase in handling capacity at the port—achieved by widening quays, constructing new dry storage and tank facilities, installing additional cranes and other mechanical equipment, palletizing cargo, and operating frequently on a round-the-clock basis—it soon became evident that Matadi could not cope with the relentless pressure of existing traffic. Despite strong desires to adhere to the principle of employing the national route, it has become necessary for Belgian Africa to use foreign outlets (Fig. 2) to an increasing degree.[5]

The waterfront of Matadi now comprises several termini, all lying on the left bank of the Congo River from the rapids to the Angolan border (Fig. 1A). Construction of the port involved great problems because of the nature of the terrain, there being only small patches of flat land along the shore. Every bit of level space for the port area has had to be blasted out of the steep hills which rise abruptly from the river. The narrow width and the velocity of the stream at Matadi allowed only the installation of marginal

[5] A discussion of Congo's transit trade through Angola may be found in W. A. Hance and I. S. van Dongen, "The Port of Lobito and the Benguela Railway," *The Geographical Review*, Vol. XLVI (1956), pp. 460–87.

FIG. 3. Matadi deepwater port viewed from the hills on which the town is located. Note the steep profile of the right bank of the Congo opposite the port installations, and the narrowness of the river channel at the site. The difficult passage of the Devil's Cauldron is just beyond the constriction of the river seen in the rear. (I. S. v. D.)

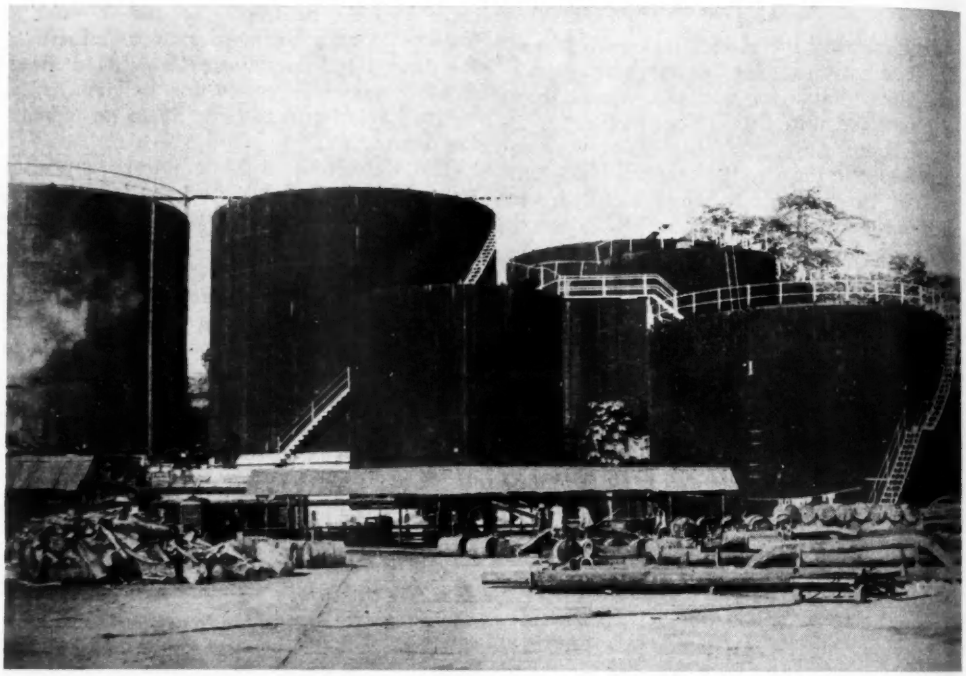

FIG. 4. *Huileries du Congo Belge* tankage installations for bulk palm oil, just outside the Otraco port area at Matadi. (I. S. v. D.)

quays. Moreover, not all of the river frontage on the south side is suitable for development, for use of a considerable stretch of shore is precluded by the proximity of the Devil's Cauldron. Extension of the port to the opposite bank of the river is discouraged by a still sharper profile right to the water's edge. It has been possible to install additional facilities at Ango Ango, below the Cauldron, but this site has topographic and hydrographic difficulties comparable to those at Matadi itself.

The main port area at Matadi (Figs. 1C and 3) has two deepwater quays with alongside depths of 25–31 feet and a total berthing length of 1,150 yards, a 130-yard cabotage and lighter quay called *Quai de Venise*, and a section of partly improved river shore used mainly for lumber and copper storage. In addition, the new 600-yard *Quai de Kala Kala* has been under construction to the west since 1949. Its date of completion is still uncertain because the nature of the river floor and the force of the current have created unexpected difficulties. Total covered shed space at Matadi is about 42,000 square yards in seven sheds; three more sheds are being built at Kala Kala. Bulk palm oil storage is available in three tank farms of which the most important is that of H.C.B. (*Huileries du Congo Belge*—Fig. 4), a subsidiary of "Unilever" international interests.

The port annex of Ango Ango is situated seven miles downstream from the main port. The petroleum terminal here (Fig. 5), managed by "Socopetrol" (*Société d'Entreposage des Produits de Pétrole*), a consortium of four marketing companies, receives tankers at a floating pontoon anchored in the river. The bulk products are pumped into the tank depot with a total capacity of 55,000 metric tons. Two pipelines, one of 4 inches for gas oil and one of 6 inches for gasoline, transmit these fuels to Leopoldville. Packaged petroleum products, except lubricants and greases, are also handled here prior to shipment inland by rail or down the estuary by barge. The ratio of packaged fuels to piped fuels transmitted from the port is about 1:3.

Ango Ango also has some bulk palm oil tankage of *Colohuile* which occasionally uses

FIG. 5. Ango Ango, the petroleum terminal and outport of Matadi, downstream from the Devil's Cauldron. Note the sharp bend of the Congo River on its way to the sea. Nóqui, the Angolan port across the border, is on the extreme left. (I. S. v. D.)

the petroleum pontoon for loading this product. To the west of it is a small (165-yard) dry-cargo pier with some sheds where low-powered vessels unable to pass by the Cauldron can unload. Ships' tackle is used in operations at this wharf. The latest addition to Ango Ango is the fish processing plant of "Pemarco" (*Pêcheries Maritimes du Congo*), which has a small fleet of trawlers for deep-sea fishing 150 miles off the Atlantic coast. Its products are marketed primarily in Matadi and Leopoldville.

A characteristic feature of Matadi's port operations is the extensive use of lighters both for loading and unloading on the outboard side of berthed vessels and for storage of such commodities as palm kernels, cotton, zinc concentrates, and cassiterite (Fig. 6). This practice, reminiscent of the importance of barging in metropolitan Belgian transport, has permitted considerable savings over construction of additional sheds in the restrictive terrain of Matadi. Use of lighters has helped Matadi to gain the best loading record of all seaports on the western African coast. On the other hand, it has also been deplored because it increases the number of times goods must be handled in the port.[6]

Another characteristic of Matadi is an almost exclusive dependence on African employees in both lower and intermediate supervisory ranks. In 1955 the port labor force consisted of 3,692 Africans and only 125 Europeans.[7] The comparatively small number of European overseers probably accounts for the less rigorous standards of orderliness than those encountered in many African ports. But the work performance of local Bacongos, most of whom come from neighboring Angola, is truly impressive by African standards.

It is difficult to estimate the capacity of

[6] K. Bollengier, *Le Port de Matadi: Faut-il Établir un Port à Banana?* Institut Royal Colonial Belge, Mémoires, Section des Sciences Techniques, Vol. IX (1953), No. 3, p. 16.

[7] Otraco, port administration records.

FIG. 6. Storage in lighters at *Quai de Venise*, Matadi, upstream of the deepwater quays. Uncovered lighters in the foreground contain cassiterite; in those covered with tarpaulins are bales of cotton and palm kernels. The railroad station and yards are to the left. (Courtesy Congopresse)

Matadi and Ango Ango because of uncertainties regarding the difference between theoretical and practical handling capacities. In 1949, a practical handling capacity of 2.6 million tons was attributed to the two ports[8] and Bollengier estimated that, upon completion of Kala Kala quay, there would be a total capacity of 4.4 million tons.[9] Based upon the actual cargo turnover at Matadi and Ango Ango and upon the average handling figure of 200–240 thousand tons annually per berth applicable to most African ports, these figures appear high, especially since berth 1 is frequently not operating due to filling-in. Two recent estimates support the contention that the capacity should instead be rated at 2.6 million tons upon completion of Kala Kala quay.[10] Increased handling of fluid products at Ango Ango, now about 340,000 tons, would increase these figures considerably without requiring additional berth space.

For the future, it has been suggested that an additional 2,400 yards of deepwater accommodation might be constructed by utilizing all of the suitable left-bank space from Matadi to the Angolan border, near which the small Portuguese port of Nóqui is located. If the present rate of growth in tonnage handled continues, it will be necessary to plan for increased capacity in the relatively near future. There are alternatives, however, to expanding Matadi. Greater use could be made of extra-national lines such as the Benguela Railway to Lobito, the "Congo-Océan" line from Brazzaville to Pointe Noire, and the Indian Ocean routes via the East African and Rhodesian Railways (cf. Fig. 2). But there is a strong tendency to handle as much traffic as possible on Congo's national routes and at a Belgian Congo port. Eventually this may require bridging the Congo near Matadi and building a rail line through difficult terrain

[8] Belgium, Ministère des Colonies, *Plan Décennal pour le Developpement Économique et Social du Congo Belge*, Vol. I (Brussels, 1949), pp. 173–74.

[9] Bollengier, *op. cit.*, pp. 52–54.

[10] J. Le Boeuf, "Les Grands Ports Maritimes Assurant le Traffic du Congo Belge," p. 61, and A. Jacobs, "La Manutention dans les Ports du Congo Belge," p. 421, in Belgium, Ministère des Colonies, *Comptes-Rendus des Journées d'Etudes des Transports au Congo Belge, Bruxelles, 5–6 Oct. 1956* (Brussels, 1957).

TABLE 2.—COMMODITY TRADE OF BELGIAN AFRICA, AT VARIOUS SEA GATEWAYS, 1955[1]
(in metric tons)

Commodity	Matadi (including Ango Ango)	Lobito	Mombasa	Dar es Salaam	Beira	Durban	Port Elizabeth	Pointe Noire	Boma[2]
EXPORTS									
Oils and fats	176,898	916	264	1	–	–	–	157	13,508
Oilseeds	47,494	–	–	–	–	–	–	–	19,683
Oilcake	53,070	–	–	–	–	–	–	–	–
Cotton fiber	36,697	4,187	–	186	–	–	–	–	–
Fibers other than cotton	5,217		–	–	–	–	–	–	–
Coffee	21,336		3,628[3]	18,398	–	–	–	–	165
Hevea rubber	25,623		–	–	–	–	–	–	570
Maize and manioc products	21,623		–	–	–	–	–	–	–
Cacao	2,308	61	–	–	–	–	–	–	1,170
Essential oils	35		6	24	–	–	–	–	–
Fruit (mostly bananas)	3,531		–	–	–	–	–	–	25,581
Other vegetable produce	17,002		571	2,695	602	–	–	–	8
Hides and skins	112	57	84	1,067	–	–	–	–	3
Lumber (logs and processed)	89,261	4	–	–	–	–	–	–	64,692
Copper metal	90,251	45,090	–	–	70,458	–	–	21,428	–
Tin or zinc metal[4]	2,527	17,410	–	–	15,533	–	–	–	–
Other minerals	80,914	330,981	109	839	–	–	–	–	–
Varia	3,457	10	–	233	–	–	–	3	35
TOTAL	677,356	398,716	4,662	23,443	86,593	–	–	21,588	125,415
IMPORTS									
Foodstuffs, drinks and tobacco	116,984	5,856	294	4,528	327	37	73	36	6,500
Textiles and wearing apparel	20,026	3,073	–	2,331	338	–	–	–	228
Metals and metal manufactures	193,352	34,541	633	10,001	520	–	82	22	3,431
Fuels (petroleum and coal)	459,209	83,781	2,302	15,469	–	–	–	–	2,959
Lime, cement and other construction materials	208,928	3,712	2,236	7,612	–	–	–	–	21,756
Chemicals, pharmaceuticals, fertilizers and explosives	43,756	5,675	103	834	102	–	–	–	627
Machinery in general	21,476	9,334	394	1,381	168	–	83	–	450
Electrical appliances	10,985	9,477	91	881	42	–		–	227
Motor vehicles	22,129	4,012	224	3,452	56	43	1,347	27	680
Railroad equipment	3,242	7,290	–	41	–	–	–	–	992
Fluvial craft	8,090	–	–	–	–	–	–	–	–
Lumber and wood manufactures	3,705	158	–	106	–	–	–	–	101
Paper and materials	16,198	2,281	–	–	–	–	–	–	–
Varia	22,651	3,518	312	1,660	180	9	110	12	445
TOTAL	1,150,731[5]	172,708	6,589	48,296	1,733	89	1,695	97	38,396

[1] Source: Condensed from data in Belgian Congo, Secrétariat Général, Section Statistique, *Bulletin Mensuel du Commerce Extérieur du Congo Belge et du Ruanda-Urundi*, Vol. VI, No. 12 (Dec. 1955), pp. 287–94, and Vol. VII, No. 2 (Feb. 1956), pp. 185–88.

[2] It should be noted that Boma serves its own distinctive hinterland in the Mayumbe and does not compete for traffic of the interior Congo Basin.

[3] Coffee and tea for Mombasa.

[4] Tin metal for Matadi; zinc metal for Lobito and Beira.

[5] Of this total, 336,529 tons entered at Ango Ango (petroleum fuels, 333,724t.; fish, 2,595t.; varia, 210t.).

on the right bank of the lower river to Boma or Banana.[11]

Traffic at Matadi

Principal imports and exports of Belgian Africa through Matadi and other ports serving the area are shown in Table 2. Before the war and up to 1949, exports exceeded imports by volume; since that year the situation has been reversed. In 1955 the volume of import cargo handled was 1,150,731 metric tons valued at $23 million of which 814,202 tons were landed at Matadi and 336,529 tons at Ango Ango. Exports, inclusive of a few hundred tons lifted by coasters at Ango Ango, were 677,356 tons valued at $11.5 million.[12]

Whereas the flow through the extra-national outlets of Lobito and Beira is predominantly mineral traffic, the outbound shipments via Matadi are chiefly agricultural and forestry products. These have been drawn to Matadi not only because it is the closest to most producing areas, but also because of a favorable rate structure and the low cost of transport over the vast interior waterway system converging naturally on the Leopoldville–Matadi axis.[13] On the other hand, large-scale mineral shipments from the Katanga are discouraged from following the route to Matadi by the necessity for two additional transshipments and by the longer distance as opposed to direct and shorter rail connections to Beira or Lobito. To compensate for the handling of less lucrative agricultural export traffic the port has always endeavored to secure the lion's share of higher-valued imports, consisting mainly of general cargo and petroleum products. The latter are the only bulk products appearing in Matadi's import traffic.

Belgian flag ships, belonging to a single transport organization,[14] have long been dominant at Matadi, measured by number, gross registered tonnage of vessels calling, or in cargo handled (Fig. 7). This supremacy is assured by three factors: (1) the direction of Belgian African trade, 36.0 percent of imports by value coming from Belgium and 51.8 percent of exports being destined to that country in 1955; (2) the preference given by important Congo shippers to national shipping, particularly between the Congo and North America, the second ranking area of origin and destination,[15] and (3) indifference of many U. S. firms toward patronage of their national lines. There is also evidence that tie-in agreements requiring use of Belgian bottoms are included in some contracts involving sales and construction in the Congo.

As a result of the high proportion of outbound tonnage shipped in Belgian vessels, foreign flag ships at Matadi have often been handicapped by a heavy imbalance in shipments, their inbound cargoes exceeding outbound traffic by as much as 60 percent. They also pay heavier port dues than the Belgians because only the total yearly gross registered tonnage of Belgian shipping calling at the port is high enough to qualify for reduced charges. United States shipping, in particular, makes a poor showing among the foreign fleets visiting Matadi, especially in relation to

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[11] P. Van Deuren, "Banana, le Grand Port de Vitesse de la Colonie," *Institut Royal Colonial Belge, Bulletin des Séances*, Vol. XXII (1951), pp. 1054–65, and Bollengier, *op. cit.* G. Weigend has reviewed some of the arguments pertaining to this discussion in "River Ports and Outports, Matadi and Banana," *The Geographical Review*, Vol. XLIV (1954), pp. 430–31.

[12] Belgian Congo, Conseil du Gouvernement Général, *Discours du Gouverneur Général—Statistiques 1955* (Leopoldville, 1956), p. XXXVII.

[13] The ton-km. cost of river transport is only one-third of that on the Congo rail system. See A. Detroux, "La Valeur Relative des Frais de Transport dans les Prix de Revient," *Comité Spécial du Katanga, 50me Anniversaire, Comptes-Rendus du Congrés Scientifique, Elisabethville, 1950*, Vol. VIII, pp. 42–51.

[14] The C.M.B. (*Compagnie Maritime Belge*) with its affiliate the C.M.C. (*Compagnie Maritime Congolaise*) which operates a route between the Atlantic ports of North America and the Congo–Angola coast as the Belgian–African Line. At one time C.M.B. had a monopoly on traffic between Antwerp and Matadi, but the Congo Basin treaties prohibiting trade restrictions permitted such foreign lines as *Holland–West Afrika Lijn* (Dutch), "Dafra" Line (Danish) and *Sociedade Geral de Indústria, Comércio e Transportes* (Portuguese) to gain minor shares in the Antwerp trade. A brief history of C.M.B. activities may be found in J. Le Boeuf, "Les Lignes Maritimes Servant le Congo," *Journées d'Études des Transports, op. cit.*, pp. 55–58.

[15] The United States took 16.7 percent of Congo exports by value and supplied 19.4 percent of its imports in 1955. U. S. Department of Commerce, "Trade of the United States with Africa, 1955, and Comparisons with 1952–54," in *World Trade Information Service, Statistical Reports* (Washington, D.C., September, 1956).

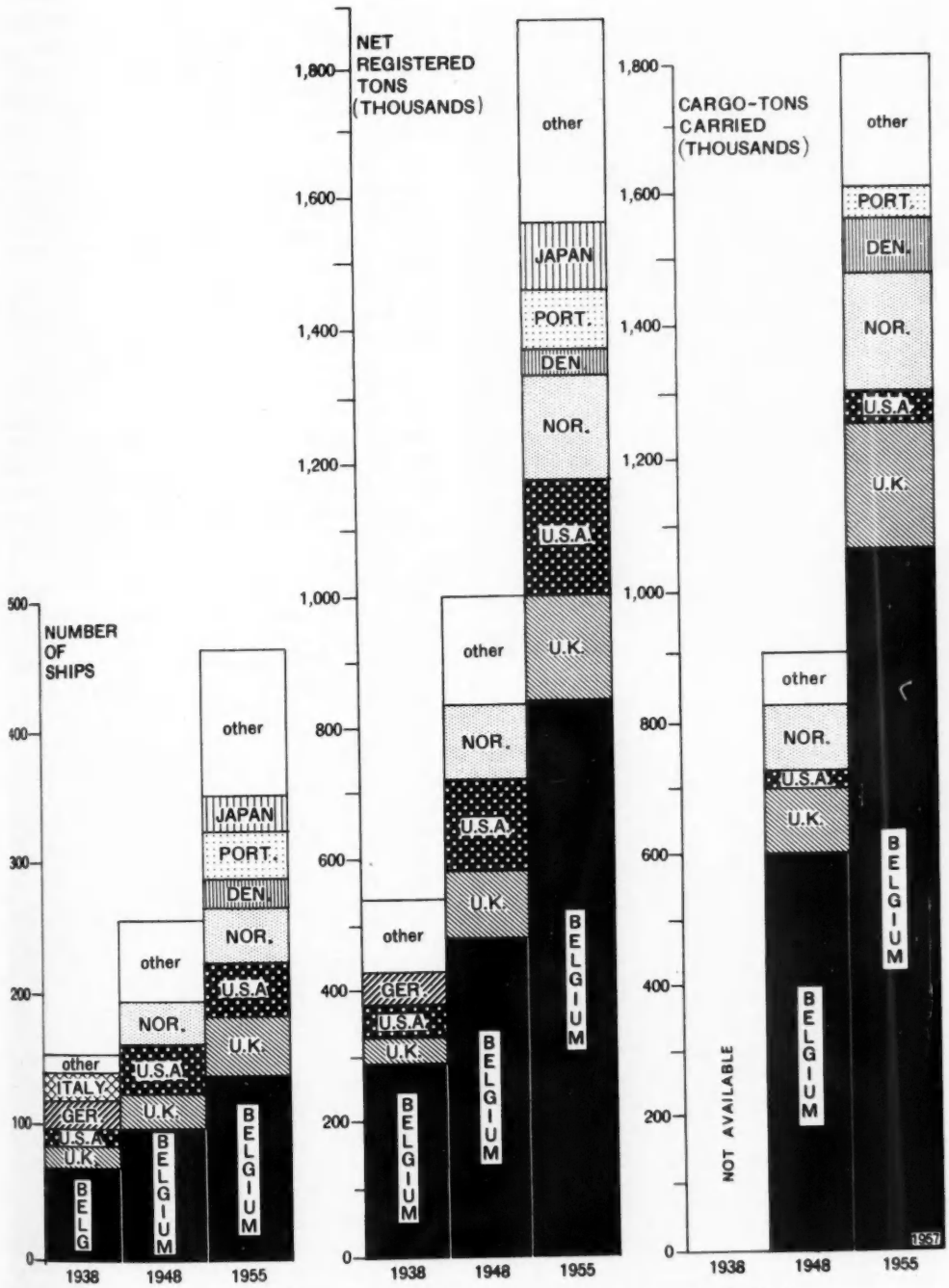

FIG. 7. World shipping at Matadi, by national registry, 1938, 1948, 1955.

FIG. 8. The steep streets of Matadi. A view of the commercial section above the port area. (I. S. v. D.)

the capacity offered.[16] Denmark, for example, with a much lower shipping tonnage on the Congo run, surpasses the U. S. in volumes lifted and unloaded at Matadi.

The City of Matadi

As has been stated, Matadi is essentially an outpost of Leopoldville and an appendage of the Matadi–Leopoldville rail line. Likewise, the city of Matadi is principally an appendage of the port. There is little in Matadi beyond the port area and the residential and shopping areas of the African and European personnel of Otraco. Constantly climbing toward the summits of the surrounding heights in an effort to escape the steaming heat of the low Congo shore, the town has painfully implanted its houses on the rocky hills (Fig. 8). Population has grown with the postwar increase in port traffic and is now about 77,000.[17]

There is no industry at Matadi except limited woodworking and repair shops. Further development of manufacturing is discouraged by lack of raw materials, inadequate public utilities, and difficult terrain. Eventually, the much publicized development of hydroelectric power on the Congo at Inga Falls[18] upstream from the port may benefit Matadi, but it is also possible that the town may be by-passed in favor of a location farther downstream on the right bank for contemplated aluminum refining plants. The trading function of Matadi is limited to retail shops, chiefly in the hands of the Portuguese who have long been a strong ethnic community in western Congo. Forwarding and brokerage activities are poorly represented because these functions are largely handled by Otraco. Warehousing is also kept to a minimum because exports from the interior are stored and sorted at Leopoldville. Matadi only breaks incoming shipments into three lots, those destined to lower Congo areas, those terminating in Leopoldville, and those for interior destinations beyond Stanley Pool, which are handled in detail at Leopoldville.

MATADI–LEOPOLDVILLE CONNECTIONS

Ninety-five percent of the cargo handled at Matadi moves over the Matadi–Leopoldville railway. Some independent Portuguese operators, however, have trucks which use the ferry from Matadi to serve the eastern part of Mayumbe. These supply general merchandise to petty traders in the rural districts and bring back food and fuel wood for African markets in the city. Timber concessionaires and banana plantations within a radius of 30–50 miles usually do their own hauling to Ma-

[16] The two American registered companies working the U. S.–Congo route are the Farrell Lines of New York and the Delta Lines of New Orleans. In addition to the strong competition from the Belgian–African Line they compete for traffic with the Barber West African Line, American-owned but under Norwegian registry, and with the British Elder Dempster Line. Tie-in agreements, mentioned above, and the desire to reduce dollar expenditures are important explanations for the relatively poor position of United States shipping at Matadi.

[17] In 1938, population was 445 Europeans and 11,003 Africans; in 1954 it was 1,777 Europeans and 75,526 Africans (Matadi, territorial administration records).

[18] Potential capacity at Inga has been estimated at 20 million kilowatts, no less than a fifth of total electric generating capacity of the United States. A good analysis of the project is available in W. L. De Keyser and I. de Magnée, "L'utilisation de l'Energie Hydroélectrique du Bas-Congo," *Revue de l'Université de Bruxelles*, 9th Year (1957), pp. 282–92.

tadi, but some of them also employ the Portuguese truckers. No through transport of Matadi's cargo is undertaken over the highway existing between Matadi and Leopoldville.

In 1954, Sabena instituted a special sea–air service featuring a moderately priced interior distribution by air of cargo arriving at Matadi by ship. The service saves several days on delivery even to Leopoldville, and about 15 to 20 tons are now flown inland each week from Tshimpi (Matadi) airport located across the river from the port (cf. Fig. 1B). The shortage of refrigerator cars on the railway explains the importance of perishable food movement by this service.

The single track Matadi–Leopoldville line cuts laboriously through the Crystal Mountains in a route that has involved much cutting, filling, and bridging (Fig. 9). It has been greatly improved from the initial 2-foot gauge railway which was completed in 1897. The original route was reduced by 43 miles in 1932 to the present 227 miles between Matadi and Leopoldville, and the gauge was widened to 3 feet, 6 inches. Curves have also been reduced (minimum radius, 492 ft.), gradients lowered (maximum gradient, 1.7 percent), and heavier track has been installed (66–88 lb.). But characteristics of the line still limit train speeds to 37 miles per hour and maximum axle loads to 18 metric tons. Equipment has lately been modernized and augmented. There are at present some 3,000 freight cars in service, mostly 35–40-ton capacity, and dieselization of power equipment is near completion. The line will doubtless be electrified when the hydroelectric power from Inga Falls becomes available.[19]

In 1955, traffic on the Matadi–Leopoldville railway totalled 2,447,000 metric tons, representing a four-fold increase over prewar years (Table 3). With 9 trains moving each day in each direction, the line has the highest traffic density and heaviest carriage of freight per mile of open track of all Congo rail systems. However, the B.C.K. (*Chemin de Fer du Bas-Congo au Katanga*) has always had a higher total traffic volume because of heavy local haulage of minerals.

The Matadi–Leopoldville railway is essentially a through line, some eighty percent of its tractive power and freight-car capacity being absorbed in the carriage of external

[19] Further characteristics of this line are given in A. Detroux, "Exposé des Transports au Congo Belge en 1955," *Journées d'Études des Transports*, *op. cit.*, pp. 33–54, and in Otraco annual reports, notably *Rapport 1955* (Brussels, 1956).

FIG. 9. The Matadi–Leopoldville rail line cutting through the Crystal Mountains toward Leopoldville. The bridge over Mpozo River. (Courtesy Congopresse)

TABLE 3.—VOLUME OF TRAFFIC AND TRAFFIC DENSITY ON BELGIAN CONGO RAIL SYSTEMS 1938, 1948, 1955[1]

Rail systems	1938			1948			1955		
	Length of track[2]	Volume of traffic[3]	Density of traffic[4]	Length of track[2]	Volume of traffic[3]	Density of traffic[4]	Length of track[2]	Volume of traffic[3]	Density of traffic[4]
Chemin de Fer de Matadi à Léopoldville (C.F.M.L.)	365	611	525	365	1,246	1,017	434	2,477	1,578
Chemins de Fer du Bas-Congo au Katanga (B.C.K.)	2,357	2,762	199	2,355	4,243	393	2,556	5,191	613
Chemins de Fer du Congo Supérieur aux Grands Lacs Africains (C.F.L.)	763	169	49	849	294	98	839	539	194
Chemin de Fer du Mayumbe (C.F.M.)	140	102	48	140	159	81	140	162	75
Chemins de Fer Vicinaux du Congo (C.V.C.)	840	60	24	840	87	31	840	150	61
Chemin de Fer du Kivu (C.F.K.)	94	13	11	94	41	38	94	83	75

[1] Sources: 1938 and 1948—E. J. Devroey, *Réflexions sur les Transports Congolais à la Lumière d'une Expérience Américaine*, Institut Royal Colonial Belge, Mémoires, Section des Sciences Techniques, Vol. V, No. 4 (1949), pp. 48–54, 74; 1955—Belgium, Ministère des Colonies, Direction des Études Économiques, *La Situation Économique du Congo Belge et du Ruanda-Urundi en 1955* (Brussels, 1956), table XXIII. Densities calculated from these sources.

[2] Length of track in kilometers.

[3] Volume of traffic in thousand metric tons.

[4] Density of traffic in million ton-kilometers per route-kilometer.

trade. Eighty percent of the through traffic is dry cargo, 15 percent bulk liquids, such as fuel and palm oil, and 5 percent Otraco service traffic including coal moving from end to end of the line. The ton-mileage of local traffic is far below that of through traffic, but the local traffic tonnage is about 45 percent of the total. This is explained by heavy short-distance movement of wood, fuel, stones, cement from the plant at Lukula on the line and other construction materials, staple goods for the large African population in the two ter-

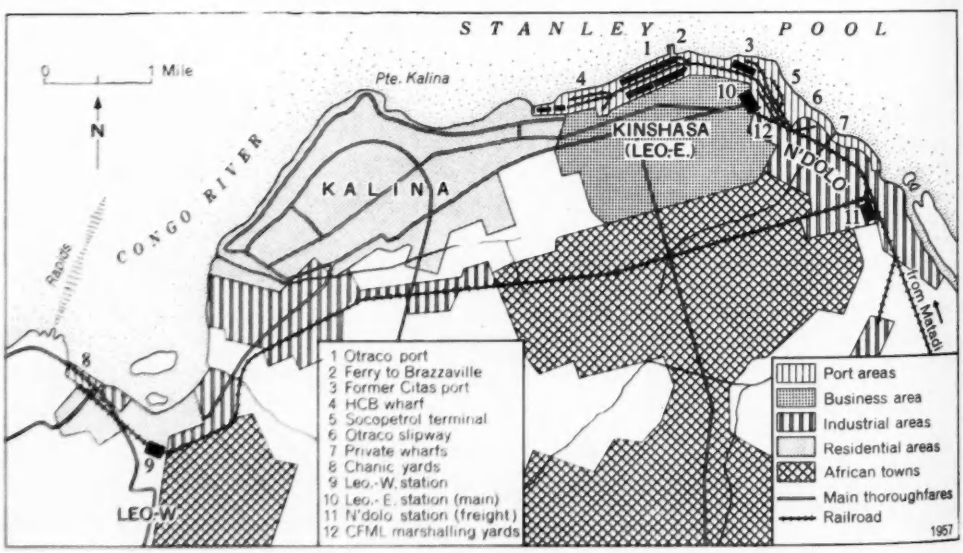

FIG. 10. Leopoldville rail–river terminal and city.

FIG. 11. Leopoldville river front on the left shore of Stanley Pool. In the foreground is the public port of Otraco with various river craft alongside the quays. (Courtesy Congopresse)

mini, and sugar from the line-side mill at Moerbeke-Kwilu.

Estimates of the potential carrying capacity of this rail line range from 2 to 3 million tons a year.[20] Introduction of automatic signalization and enlargement of terminal switchyards would allow a rise up to 5 million tons without doubling the track except for a short distance from Leopoldville.

LEOPOLDVILLE RAIL–RIVER TERMINAL

Leopoldville (Figs. 2 and 10), the inland terminus of the rail from Matadi, is at the point of convergence of the vast, fan-like Congo River system. Almost all inland traffic destined for the ocean port must at some time be waterborne en route to the Leopoldville river port. As at Matadi, a large part of the port facilities are operated by Otraco, which now has public quays totalling 1,070 yards (Fig. 11). These consist of the old Otraco space completely re-equipped in recent years, and a section to the east taken over from "Citas" in 1955.[21] The first area now specializes in import traffic and the second in export cargo. The total shed space of the public port is 81,354 square yards.

The privately owned terminals of importance are those of *Huileries du Congo Belge* and Socopetrol. The first handles about 110,000 tons of oil palm products yearly; the latter petroleum depot includes the receiving facilities of the Ango Ango–Leopoldville pipelines, a drum manufacturing plant, a tetra-ethyl blending plant, plus storage, pumping, and filling equipment. Additional tankage was built in 1956 at nearby Masima to bring total capacity to 42,000 cubic meters. The port of Leopoldville also contains a number of smaller private "beaches," the small terminal of a ferry connecting with Brazzaville, Otraco shipyards, a waterway patrol station, and, somewhat removed to the west, the shipyards of "Chanic" (*Chantier Naval et Industriel du*

[20] Otraco administration records; *Plan Décennal . . . , op. cit.*, p. 138.

[21] The "Citas" quay was used chiefly by the subsidiaries of *Société Générale de Belgique*, the most powerful financial combination in Belgian Africa. In 1954, prior to the expiration of its concession and its absorption by Otraco, Citas handled about one-third of total river cargo at Leopoldville.

Congo) which repair and assemble yearly some 8,500 tons of river craft.[22]

The total river traffic of Leopoldville has doubled each decade and in 1955 reached 1,348,900 tons, about three-sevenths moving downstream to Leopoldville and four-sevenths going up river. Otraco handled over half of this traffic as compared with 26.8 percent in 1938.

The great problem of Leopoldville's port has been inadequate space behind the river front, not because of topographic barriers as at Matadi but because the business section of the city was constructed immediately adjacent to the early port facilities, thus restricting the possibilities for expansion. Suggestions for port extensions include the building of an outport 21 miles upstream at Kimpoko, considered the most suitable site, but removal of some of the port facilities such a distance would make for substantial inconvenience in distribution.[23]

Although it is outside the scope of this paper to examine the Leopoldville urban agglomeration in detail, its territorial importance is suggested by its mushrooming population, which grew from 46,000 to over 300,000 in the past 15 years, making it the largest city in the central belt of Africa. The European population increased in the same period from 3,000 to 15,740. Sprawling outward and pushing upward, the city is constantly pressing its own limits in housing, municipal transport, supply of power, and educational facilities. Unlike Matadi, it is not just a transshipment point, but an important consuming and producing center in its own right. Its major industries include textile and clothing factories, woodworking and food processing plants, and production of beer and soft drinks. At least 10 percent of inbound freight from overseas sources carried on the Matadi–Leopoldville line is retained in the capital; 30 percent of goods arriving by the river are absorbed by Leopoldville's consumers and industrial establishments. Large quantities of foodstuffs are trucked in from market gardens in the lower Congo area, while fresh meat is regularly flown from Angola and the Chad Territory, as are European delicacies from Belgium.

[22] See A. Lederer: "Les Chantiers Navals au Congo Belge," *Journées d'Études des Transports, op. cit.*, pp. 261–87.

[23] See plan for Kimpoko facilities in *Plan Décennal . . . , op. cit.*, pp. 186–87.

THE TIES OF MATADI'S TRIBUTARY AREA WITH THE PORT

Since the completion of the rail line from Elisabethville, the capital of the Katanga, to Port Francqui on the Kasai in 1928 the economic hinterland of Matadi theoretically coincides with the limits of Belgian Africa except for the Mayumbe region, served largely by Boma.[24] Between 1906 and 1928 the southeastern portion of Congo relied on Beira in Mozambique and on Union of South Africa ports.

To induce Congo trade to flow via Matadi two special systems of commodity and through rates were adopted in 1932. Under the system of *échelles mobiles* Congo transport rates vary with the world prices of commodities shipped. *Tarifs inter-réseaux* are low through-rates seeking to bring the national route into parity with shorter and less costly foreign routes.[25] Several reorganizations of the administrative structure of Congo's transport have been carried out with the same end in view.[26]

But the pull of the Lobito route, opened in 1932, and to a lesser extent of Beira, on the mineral traffic of the Elisabethville–Kolwezi mining–industrial area remains very strong (cf. Table 2). Other gateways share less prominently in the foreign trade of the Congo (cf. Fig. 2). Some imports, chiefly motor vehicles, continue to come via Port Elizabeth and Durban.

Dar es Salaam has always handled some

[24] Boma is now equipped with 770 yards of deepwater quay. Some 270 vessels called at the port in 1955, loading and unloading 163,811 tons of cargo. The 2-foot gauge, 87-mile Mayumbe railroad, C.F.M. (*Chemin de Fer de Mayumbe*), from Boma to Tshela, also operated by Otraco, has been inadequate to serve the region's needs and a first-class highway is scheduled to augment or replace it. The chief exports of Boma are lumber, bananas, and oil palm products. Mining of copper in the area is contemplated.

[25] See G. Bousin, "Quelques Considérations sur la Voie Nationale des Transports Congolais," *Institut Royal Colonial Belge, Bulletin des Séances*, Vol. XXIII (1952), pp. 685–97, and A. Huysbrechts, "La Formation des Prix du Chemin de Fer de Matadi à Léopoldville (1898–1954)," *Bulletin de l'Institut de Recherches Economiques et Sociales de l'Université de Louvain*, Vol. XXI (1955), pp. 501–55.

[26] The most recent government decrees have created a *Conseil Supérieur des Transports au Congo*, an advisory body, and the *Commission des Transports Intérieurs*, a legislative and executive body. There is also a private organization of common carriers, "Comitra" or *Comité des Transporteurs au Congo Belge*, with headquarters in Brussels.

traffic to and from Ruanda–Urundi and the eastern Congo, and a special deepwater berth now exists at this port to handle Belgian African movements.[27] A trickle of goods moves via Mombasa, and the extension of the Uganda rail line to the Congo border should stimulate the flow on that route. Finally, some copper purchased by the French government has recently used the Brazzaville–Pointe Noire gateway. But the Congo has typically ignored this alternate routeway from Stanley Pool for its own use ever since an incipient tariff war in the late thirties was averted by an agreement limiting the French Equatorial African and Belgian Congo transporters to the exclusive service of their national territories. Even when the Leopoldville–Matadi axis was jammed beyond capacity, free space on the alternate French route was not utilized for Belgian African traffic.

The 1955 traffic pattern in the hinterland of Matadi is shown in Fig. 12B. It is estimated that 8 million tons of freight move yearly in Belgian African organized transport, of which 5 million tons is local traffic and 3 million tons overseas freight. Apart from the political pressure to use the national route the most important influence shaping the flow is the configuration of the Congo Basin. The system of water arteries draining to the west is the natural feeding system of the Leopoldville–Matadi axis. Generally speaking, water routes are used wherever possible; rail lines have been constructed only as accessories to the rivers, either to bypass non-navigable sections or to feed the waterways from regions without water transport. Examples of the latter type are the Katanga lines and the "Vicicongo" (C.V.C. or *Compagnie des Chemins de Fer Vicinaux du Congo*) in the Eastern Province. The Congo's highway system is well developed only in the east and southeast where, again, water transport is not possible. Successive highway development programs have often not met their time goals. But despite the somewhat inadequate roadway system, the number of trucks and cars in the Congo quadrupled between 1945 and 1955.

Table 4 shows the comparative importance of river, rail, and road traffic in the Congo for 1936 and 1955, measured in ton-kilometers of freight carried. This table reveals: (1) the great importance of waterborne movements, (2) the small change in the last twenty years in the proportion of traffic carried by water and by rail, (3) the apparently declining share of established road transport services,[28] and (4) that the transport services were called upon in 1955 to handle four and one-half times as much traffic as in 1936.

TABLE 4.—DISTRIBUTION OF GOODS TRAFFIC FLOW IN MATADI'S TRIBUTARY AREA, BY TYPE OF CARRIER 1936 AND 1955[1]
(in thousand ton-kilometers)

Type of carrier	1936		1955	
	Ton-km. transported	Percent of total	Ton-km. transported	Percent of total
Railroads	493,013	53.5	2,486,100	57.9
River and lake services	385,425	41.2	1,757,800	41.1
Road trucking services	49,000	5.3	46,000	1.0
Total	927,438	100.0	4,289,900	100.0

[1] Sources: 1936—E. J. Devroey, *Réflexions sur les Transports Congolais à la Lumière d'une Expérience Américaine*, Institut Royal Colonial Belge, Mémoires, Section des Sciences Techniques, Vol. V (1949), No. 4, p. 27; 1955—Belgium, Ministère des Colonies, Direction des Études Économiques, *La Situation Économique du Congo Belge et du Ruanda-Urundi en 1955* (Brussels, 1956), p. 100. In kilometers of network the approximate proportion between the various types of carrier is: rail—10 percent; waterways—30 percent; trucking routes—60 percent.

Water Transport

The total mileage of navigable rivers in the Congo is about 9,000, of which 1,650 miles are rated as first-class, 4,140 miles as second-class, and 3,200 miles as third-class waterways.[29] In

[27] Hance and van Dongen, "Dar es Salaam, the Port and its Tributary Area," forthcoming. The historical development of this eastern route is described in I. S. van Dongen, *The British East African Transport Complex*, University of Chicago, Department of Geography, Research Paper No. 38 (1954), pp. 59–60, 94–5.

[28] The figures are incomplete, however, as they do not include information on small trucking operators.

[29] The official classification of waterways is as follows:
Class I. Minimum depths: low water, 1.3 m.; high water, 2 m. For 800–1200-ton barges.
Class II. Minimum depths: low water, 1.0 m.; high water, 1.5 m. For 150–350-ton barges.
Class III. Minimum depths: low water, 0.8 m.; high water, 1.2 m. For 40-ton barges.
E. J. Devroey, *Annuaire Hydrologique de Congo Belge et du Ruanda-Urundi, 1954*, Académie Royale Coloniale Belge, Mémoires, Section des Sciences Techniques, Nouvelle Série, Vol. III (1955), No. 4, pp. 10–11; K. Bollengier, "Les Voies Navigables du Congo Belge et leur Valeur Économique," *Institut Royal Colonial Belge, Bulletin des Séances*, Vol. XX (1949), pp. 756–77.

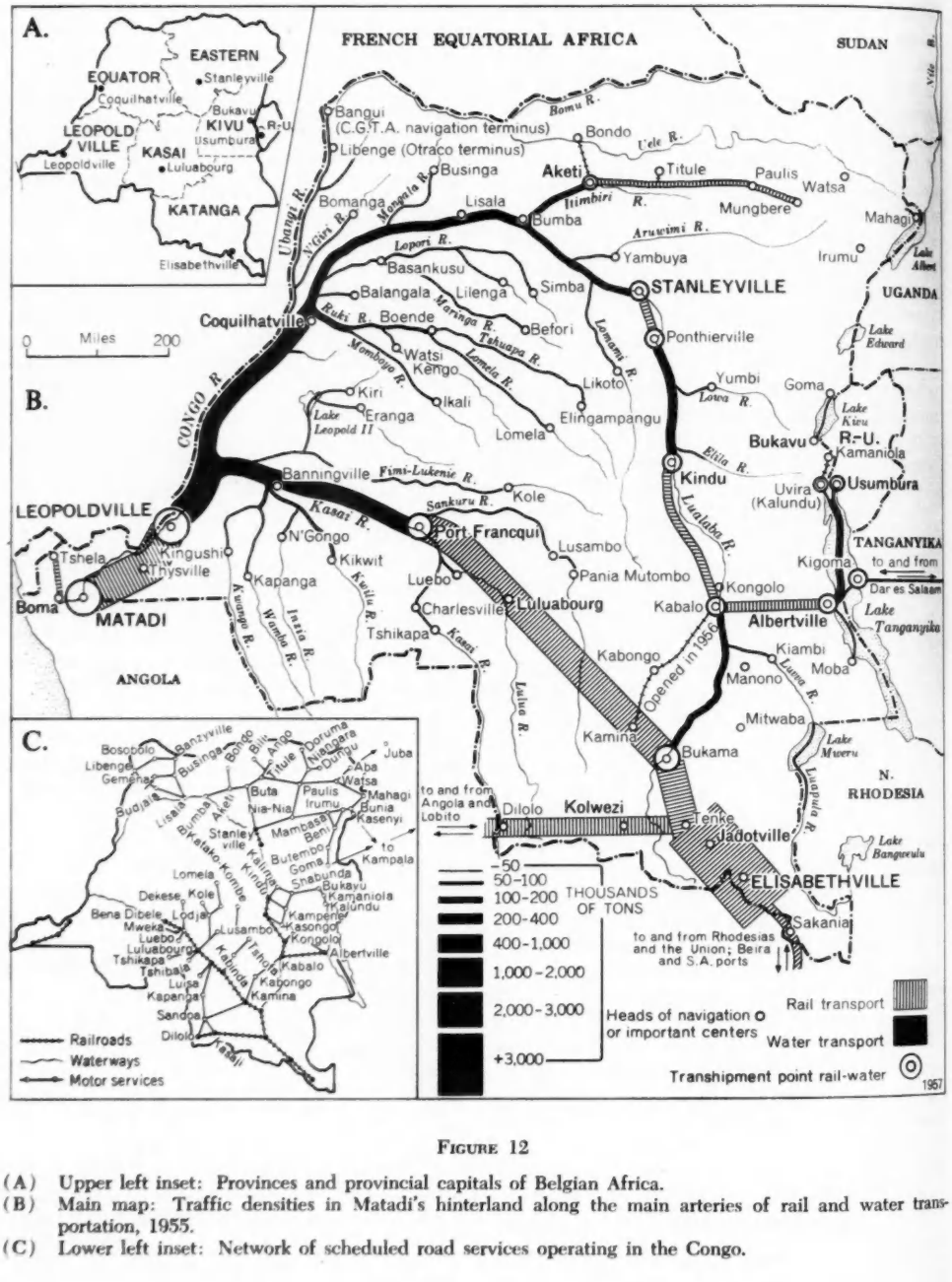

FIGURE 12

(A) Upper left inset: Provinces and provincial capitals of Belgian Africa.
(B) Main map: Traffic densities in Matadi's hinterland along the main arteries of rail and water transportation, 1955.
(C) Lower left inset: Network of scheduled road services operating in the Congo.

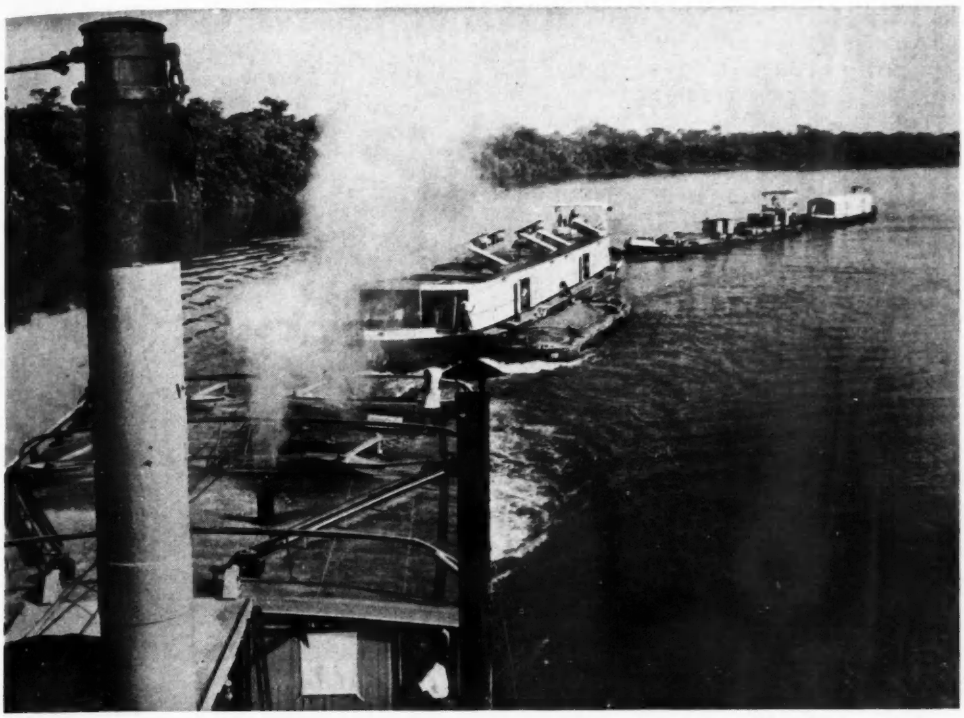

FIG. 13. Stern-wheeler towing barges on one of the navigable sections of the Lualaba River, exploited by the *Chemins de Fer du Congo Supérieur aux Grands Lacs Africains.* (Courtesy Congopresse)

addition there are some 800 miles of lake steamer routes on Lakes Tanganyika, Kivu, Albert, and Mweru, the most important of which are the northern Lake Tanganyika route and the crossing from Albertville to Kigoma, railhead of the Central Tanganyika Railway.[30]

The two most important axes of river transport are the Congo–Lualaba, especially the 1,082-mile section from Leopoldville to Stanleyville (cf. Fig. 12B), and the Kasai River to Port Francqui, 378 miles from its confluence with the Congo. The Ubangi, another important Congo tributary, is relatively insignificant in Belgian African movements, partly because traffic from the right bank is handled by French river shipping, partly because water depths are restrictive for seven months of the year. The outstanding secondary river route is probably the lower Itimbiri which connects with the Vicicongo rail system at Aketi. Though less heavily travelled, the subsidiary waterways converging on Banningville on the Kasai and Coquilhatville on the Congo are of great importance because they permit low-cost movement of goods to and from rain-forest regions where the cost of land communications would be prohibitive.

In the early years of river navigation in the Congo when capital available for development was restricted, it was the policy to adapt fluvial craft to existing channel conditions. Flat-bottom stern-wheelers operating on the main streams towed strings of low-draft barges of varying sizes (Fig. 13), which were dropped off at the junctions of shallower streams and towed to their final destinations by small tugs drawing less than 2 feet. This pattern of operation was universal until post-World-War-II years and is still important, but improvements have become imperative because of the greatly increased traffic. Luminous beacons and mirrors were installed along

[30] Services across Lake Albert are operated by the East African Railways and Harbours Administration, those across Lake Tanganyika by the Belgians. Lake Mweru traffic is handled by the local Congo administration.

the Leopoldville–Stanleyville section to permit continuous navigation, and vessels were equipped with radar to speed up traffic in darkness, fog, or driving tropical rain. After experts studied the Mississippi transport systems, integrated pushboats were introduced and diesel power began to replace the former wood-burning vessels.[31] Hydrographic observations, particularly regarding seasonal fluctuations on the rivers, have been accelerated and some of the most restricting shoals have been removed. The cargo capacity of the river fleet has been enlarged from 112,830 tons in 1948 to 243,000 tons at the end of 1954, while the towing power has risen from 29,370 to 55,690 horsepower.[32]

Additional improvements of the huge Congo water system have been proposed under the Ten-Year Program and in specific projects now being studied, such as the possible canalization of the non-navigable segments of the Lualaba to permit an all-water movement from Bukama to Stanley Pool. But operating difficulties occasioned by seasonal variation in flow, turbulent currents, shifting sandbanks, floating tree trunks, and islands of sudd, or by low forest canopy on some minor streams will probably remain as permanent obstacles to easy navigation. A new problem has been added in recent years by the appearance in mass of the water hyacinth (*Eichornia Crassipes*) for which effective methods of control are yet to be devised (Fig. 14).[33]

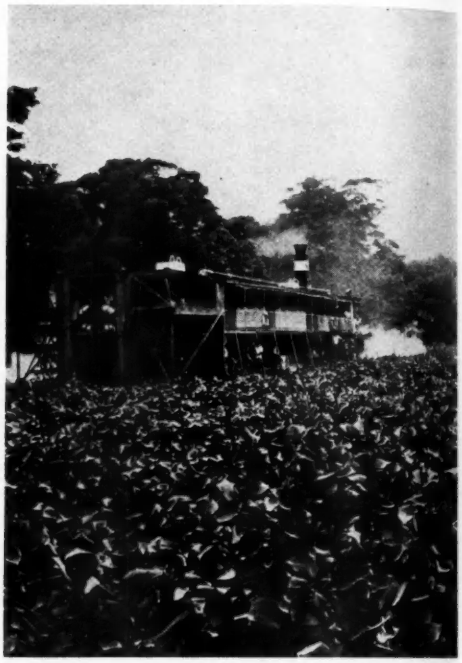

FIG. 14. Blue hyacinth obstructing the waterways of the Belgian Congo. A specially equipped boat engaged in spraying thick-growing islands of this water pest. (Courtesy Congopresse)

A host of shipping points, large and small, have sprung up along the navigable watercourses. Some are well equipped and others are little more than landing stages. The two leading river ports are Stanleyville and Port Francqui, each handling about 400,000 metric tons a year. Port facilities at Stanleyville, the third largest urban center in Belgian Africa, with a population of 65,000, include the Otraco terminal and the Simi Simi petroleum depot on the right bank, and the railway terminal on the left bank. The importance of Stanleyville wharves reflects not only the growing economic activity in the surrounding area but also the volume of traffic in transit to and from Kivu Province and the Lower Katanga over the C.F.L. (*Compagnie des Chemins de Fer du Congo Supérieur aux Grands Lacs Africains*) rail–water system.

Port Francqui (Fig. 15), at the head of navigation on the Kasai, is, in contrast, essentially a transshipment point for the flow between the Katanga and Leopoldville–Ma-

[31] The use of wood as fuel was expensive, it threatened to deforest large tracts of land adjacent to the rivers, required an excessively large labor force, slowed up operations, and reduced the space available for carrying paying cargo. The comparative advantages of various fuels were examined by C. Camus in "Les Combustibles en Rapport avec les Transports au Congo," *Institut Royal Colonial Belge, Bulletin des Séances*, Vol. XXI (1950), pp. 514–33. On the introduction of diesel power see P. A. Jacobs, "La Dieselisation du Matériel du Transport au Congo Belge," *Journées d'Études des Transports, op. cit.*, pp. 327–42.

[32] E. Voordecker, "Les Ports Intérieurs et les Transports Fluviaux," *Marchés Coloniaux* (Sept. 1955), pp. 3153–56. A detailed description of water transport equipment and traffic data for 1946–55 is given in H. Soudan, "Transport par Eau" and "La Navigation au Lac Tanganyika," *Journées d'Études des Transports, op. cit.*, pp. 185–235 and 343–407.

[33] A problem associated with water movement is the extent of pilfering occurring during the long-distance voyages. Slow movement of vegetable produce also calls for greater attention to preservation techniques.

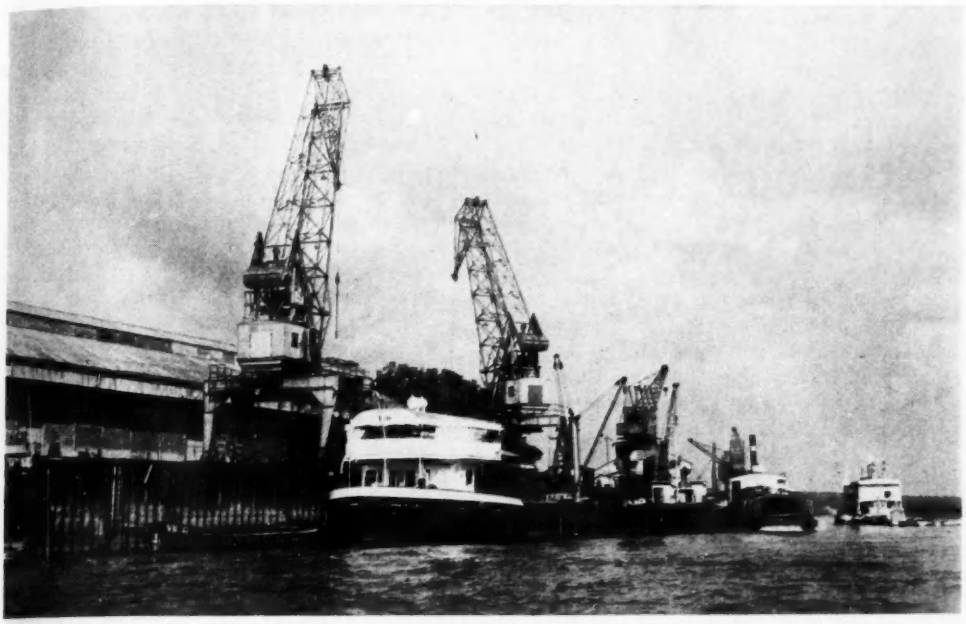

FIG. 15. The modern river port of Port Francqui at the point of transshipment from the B.C.K. rail line to the Kasai waterway. Note the height of the quay wall required by the seasonal variations in water level. (Courtesy Congopresse)

tadi.[34] Other important inland river and lake ports in decreasing order by tonnage handled are: Ponthierville, Kindu, Albertville, Usumbura, Bukama, Aketi, Kabalo, Kalundu (Uvira), Coquilhatville, Bukavu, Kongolo, Goma, Kasenyi, and Mahagi (cf. Fig. 12B).[35]

The total upstream traffic on Congo's waterways has been fairly well balanced with a slight surplus of down movements prior to 1954 and of upstream movements thereafter.

Rail Transport

Whereas water transport is paramount in the western half of the Congo Basin and one transporter, Otraco, has a virtual monopoly of all transport facilities there, in the eastern half rail movement dominates and freight is handled by several organizations. The privately owned *Chemin de Fer du Bas-Congo au Katanga*, the *Chemins de Fer du Congo Supérieur aux Grands Lacs Africains*, and the Vicicongo lines total 2,563 miles while Otraco operates the 58-mile C.F.Ki. ("Cefaki" or *Chemin de Fer du Kivu*) running from Uvira on Lake Tanganyika to Kamaniola.[36] From the standpoint of development of transport, it is fortunate that the bulk of Congo's mineral wealth is located on the eastern and southeastern periphery of the territory (Fig. 17E). Heavy mineral traffic, capable of absorbing long-distance transport charges, has attracted and justified a system of lines that could

[34] See H. Nicolai and J. Jacques, *La Transformation des Paysages Congolais par le Chemin de Fer: L'Example du B.C.K.*, Institut Royal Colonial Belge, Mémoires, Section des Sciences Naturelles et Médicales, Vol. XXIV (1954), No. 1, pp. 150–158.

[35] A graphic presentation of port activity and proposed extensions is given in Belgian Congo, Service des Voies Navigables, *Carte des Voies Navigables, Ports et Études Hydrographiques*, 1:2,000,000 (1955). See also K. Bollengier, "Les Ports du Congo Belge," *Institut Royal Colonial Belge, Bulletin des Séances*, Vol. XX (1949), pp. 354–400, and P. A. Jacobs, "La Manutention dans les Ports du Congo Belge," *op. cit.*, pp. 423–35.

[36] The future of this line, which carried 41,000 tons in 1948 and 85,000 tons in 1955, is uncertain. It may be completely replaced by motor service; it has also been suggested that a cable railway be installed between Bukavu and Lake Tanganyika. See E. J. Devroey, "Possibilités d'Emploi de Télépherique au Congo Belge," *Institut Royal Colonial Belge, Bulletin des Séances*, Vol. XXII (1951), pp. 221–43.

not have been supported by agricultural production.[37]

The rail system in the Katanga, with a total of 1,587 miles of 3-foot, 6-inch gauge line, comprises: (1) the 441-mile main trunk laid in 1906–14 through the mineralized zone from the Rhodesian frontier at Sakania to Bukama (cf. Fig. 12B) at the head of navigation on the Lualaba, plus some spurs to mining sites and hydroelectric stations; (2) the 697-mile branch (P.F.B.) completed in 1927 between Port Francqui and Bukama, permitting a reduction in the national route serving the Katanga from 2,235 miles and seven transshipments via the Lualaba–Congo routes to 1,720 miles with three transshipments via the Kasai–Congo route; (3) the 324-mile branch (T.D.) from Tenke to Dilolo on the Angolan frontier, constructed in 1928–31 to connect with the Benguela Railway to Lobito; and (4) the 125-mile Kamina–Kabongo section of the new Kamina–Kabalo line, opened in August 1956 to connect Katanga and the Upper Congo–Lakes rail systems.[38]

The *Chemin de Fer du Bas-Congo au Katanga* (B.C.K.) is the leading rail operator in Belgian Africa in both ton-mileage and freight volume transported. Its significance as a carrier is enhanced by its financial tie with *Union Minière du Haut-Katanga* (U.M.H.K.), the leading mining concern in the Congo. Both are subsidiaries of *Société Générale*. The 5,191,000 tons of freight transported by this line in 1955 represent a 100-percent increase over the tonnage moved in 1938. The greatest density of traffic on the system occurs on the Elisabethville–Jadotville section (cf. Fig. 12B) because of heavy mineral movements plus food coming from the Kasai and Lake Tanganyika areas to the mining and industrial centers of the region. Fifty percent of total traffic is in minerals.

In addition to national traffic, both intra-Congo and overseas, the Bas-Congo–Katanga system handles a small tonnage of international transit shipments (about 50,000 tons in 1955) from Lobito to the Copperbelt of Northern Rhodesia. Coal provided the great bulk of this transit movement in recent years,[39] but the Bulawayo Conference agreements of November 1956 among the Rhodesia Railways, the Benguela Railway, and the *Chemin de Fer du Bas-Congo au Katanga* will probably stimulate a more intense and more diversified transit flow, including the export of Rhodesian copper via the Katanga–Angola route.[40]

The B.C.K. system has greatly raised its capacity in recent years by re-equipment in tractive power and rolling stock and by the relaying of heavier track.[41] It was also the first railroad in central Africa to introduce partial electrification, on the 208-mile Kolwezi–Elisabethville section (Fig. 16).

The transport system of the *Compagnie des Chemins de Fer du Congo Supérieur aux Grands Lacs Africains* (C.F.L.) comprises 673 miles of rail line (Stanleyville–Ponthierville, 78 mi.; Kindu–Albertville, 443 mi.; Kabalo–Kabongo, 152 mi.) and 1,096 miles of water routes on the Lualaba (Ponthierville–Kindu, 193 mi.; Kongolo–Bukama, 491 mi.) and Lake Tanganyika (412 mi.). This system presents a good example of the difficulties besetting surface transport in the Congo, particularly the necessity for repeated transshipments. Prior to 1939, two additional breaks of bulk were required for the present Kindu–Albertville (cf. Fig. 12B) rail section because the rail between Kabalo and Kongolo had not been constructed at the start, the river being navigable in this stretch. The first C.F.L. system, not being connected with other African rail systems, operated on meter-gauge track, part

[37] See B.C.K., *Compagnie du Chemin de Fer du Bas-Congo au Katanga 1906–1956* (Brussels, 1956), for a historical description of the main Congo rail lines, particularly pp. 175–85 and graph, p. 196.

[38] Formerly section (1) was known as C.F.K. (*Chemin de Fer du Katanga*) and sections (2) and (3) as L.K.D. ("Leokadi" or *Société du Chemin de Léopoldville–Katanga–Dilolo*). In 1952, all these were combined in a new company, K.L.D., the holdings of which are operated by B.C.K.

[39] Hance and van Dongen, "The Port of Lobito . . . ," *op. cit.*, pp. 478–79.

[40] Under this agreement the Copperbelt producers have been partially released from commitments to use the Rhodesia Railways and Mozambique ports and given parity of rail freight rates for certain shipments on the Lobito, Beira, and Lourenço Marques routes. A maximum of 20 percent of total copper production may be exported via Lobito. Overseas imports are permitted via Lobito without tonnage limitation for four years, starting in January 1957.

[41] Locomotives were increased from 150 in 1949 to 202 at the end of 1955, and freight cars from 2,269 with a capacity of 75,000 tons, to about 3,500 with total capacity of 115,000 tons in the same period. B.C.K. management records (Elisabethville).

FIG. 16. Mineral traffic moving along the newly-electrified Bas Congo–Katanga rail section from Kolwezi to Elisabethville. (Courtesy Congopresse)

of which was relaid to standard 3-foot, 6-inch track when the Kamina–Kabalo junction was constructed.[42] It is too early to measure what share of the normal 130–140 thousand tons of traffic carried over the Bukama–Kabalo river section will be routed over the new rail line. But the Kamina–Kabalo cutoff is a decided improvement in trans–African connections, and has strategic as well as economic significance. It offers an alternate national route to the eastern Congo, Lake Kivu, and Ruanda-Urundi areas, reducing the number of transshipments from the last two areas via the route to Matadi from seven to five and the transport distance from 2,244 to 1,957 miles.

The combined volume of this company's traffic in 1955 was 1,182,400 tons. Over forty percent of the total was handled by the rail services, 29 percent on Lake Tanganyika carriers and 27 by the Lualaba river fleet. Rail traffic in 1955 (539,000 tons) was quadruple the prewar volume, requiring a substantial re-equipment program including dieselization of power units.[43]

The Vicicongo rail system in the northeast was built in the interwar period to serve the Uele region. In conjunction with a network of road services operated by the same company, it acts as a feeder to the Itimbiri waterway at Aketi. The 425-mile main line to Mungbere (cf. Fig. 12B) has two branches, one to Bondo (75 mi.) and the other to Titule (42 mi.). Its gauge is only 2 feet and the railroad carried only 150,000 tons of freight in 1955, of which one-third was local produce. The line has been beneficial to regional cotton producers and to the gold mining industry, but the heavy imbalance in favor of inward

[42] See the history of C.F.L. development in *1902–1952, Cinquantiéme Anniversaire de la Compagnie des Chemins de Fer du Congo Supérieur aux Grands Lacs Africains* (Brussels, 1954?).

[43] See M. Osipenco, "Le Matériel de Transport par Rail," *Journées d'Etudes des Transports, op. cit.*, pp. 115–84.

traffic and some difficulties in securing wood fuel complicate the operation.[44]

Several proposals to extend the Congo rail net have been considered in postwar years.[45] The suggestion to connect Kindu and Ponthierville on the Lualaba by rail, permitting an all-rail carriage from Stanleyville to Albertville, has not aroused great interest. A proposal to build a railway east of Stanleyville to improve communications with the Kivu area has been abandoned in favor of the Stanleyville–Bukavu highway with a branch to Goma, now under construction.

The most important and most debated[46] project involves extending the Bas Congo–Katanga line either to Leopoldville or to Thysville on the Matadi–Leopoldville route, which would permit direct rail connections between Matadi and the Katanga by eliminating the necessity to use the Congo–Kasai waterway. This proposal was dropped from the Ten-Year Plan but later received some support in Belgium under the prodding of *Société Générale*. Such a line would certainly reinforce the competitive position of Matadi and would permit savings in time and in handling expense[47] through the elimination of two transshipments, but the total cost of shipment from the southeastern Katanga to the national seaboard would be increased. Shipping rates over the proposed 542-mile connection are estimated at 156 percent of the present transport costs via the Kasai. And the Matadi–Elisabethville all-rail route would still be longer than competing foreign rail routes or 1,751 miles as compared with 1,308 for Lobito and 1,619 for Beira. Also, it must be questioned whether the capital required, estimated at $56 to $110 million depending on the route, could not at present be more effectively devoted to other transport improvements. The per-mile cost of laying the line would be high because it would run across the general north-south grain of the country. Finally, large-scale traffic on this route would require additional port facilities at Matadi or below it on the lower Congo. Despite these many disadvantages, however, it is reasonable to expect that the proposed linkage may occur sometime in the future, if for no other reason than to stimulate the use of national routeways and reduce the economic and strategic dependence on extra-national lines.

Road Transport

The total mileage of roads in Belgian Africa in 1955 was given as 85,067 miles. In the Congo there are 20,485 miles classified as main roads (*routes d'intérêt général*), 54,699 miles of secondary highways (*routes d'intérêt local*), and 10,083 miles of private roads.[48] There has been a marked expansion of road mileage in postwar years, the 1948 total having been 67,377 miles. Ruanda–Urundi has 214 miles of main highways, 1,412 miles of secondary roads, 3,799 miles of motorable tracks, and 121 miles of private roads.[49] These figures reveal little, however, regarding the quality of the Belgian African road system. As in other African areas, few roads are bituminized; even the main highways are almost all surfaced in gravel, packed sand, or laterite. Secondary highways are rarely more than dirt-surfaced. Makeshift bridges and manu-

[44] Refuelling requires a stop of 30 minutes every 60 kilometers and some 81,000 cubic meters of wood have to be obtained yearly from a none-too-well-wooded region. G. Bernard, "Note sur les Chemins de Fer Vicinaux du Congo," *Compagnie Générale des Transports Africains, Report* (Brazzaville, 1955). Relaying of track and conversion to diesel locomotives have been considered. A suggestion to extend the rail line to Bumba on the Congo has been shelved for the time being.

[45] E. J. Devroey, "Note sur les Chemins de Fer du Congo Belge," *Institut Royal Colonial Belge, Bulletin des Séances*, Vol. XX (1949), pp. 320–48.

[46] O. Jadot, "Le Programme Ferroviaire du Congo Belge," pp. 522–44; E. J. Devroey, "La Rivière Kasai et la Voie Nationale du Bas-Congo au Katanga," pp. 629–66, and L. van Wetter, "A Propos de la Crise des Transports Congolais," pp. 260–76, all in *Institut Royal Colonial Belge, Bulletin des Séances*, Vol. XXIII (1952).

[47] Each break of bulk in Congo traffic would cost the equivalent of 50 additional kilometers of rail transport and a time loss of 4–5 days. (Interview with E. J. Devroey, Brussels, February 1955). It has been suggested that the use of containers would reduce the difficulties and costs of multiple transfers, but several attempts to introduce them have been inconclusive. See P. Van Deuren, "L'Utilisation des Containers dans les Transports Congolais," *Institut Royal Colonial Belge, Bulletin des Séances*, Vol. XXIII (1952), pp. 1176–85, and "L'Utilisation des Containers dans les Ruptures de Charges au Congo," *ibid.*, Vol. XIV (1953), pp. 1038–50.

[48] Belgian Congo, Conseil du Gouvernement Général, *Discours du Gouverneur Général—Statistiques 1955* (Leopoldville, 1956), p. XXXV.

[49] Belgium, *Rapport Soumis par le Gouvernement Belge à l'Assemblée Générale des Nations-Unies au Sujet de l'Administration du Ruanda-Urundi Pendant l'Année 1955* (Brussels, 1956), p. 414.

ally-operated pontoons are common. There is, moreover, the usual problem of seasonally and temporarily impassable roads occasioned by heavy rains.

Leopoldville province now leads in the density of road net and number of vehicles registered,[50] reflecting the intensified activity of the Leopoldville urbanized area. Until the early fifties, Eastern and Katanga provinces, where rail and water transport were restricted, led in number of vehicles. Road construction in Kivu province is greatly hampered by the rugged topography of the Rift Zone and by the rainforest cover on the west. Rainforest also handicaps road building in Equator province. Despite the remoteness of Ruanda-Urundi, which is a heavy obstacle to its development, and its low level of external trade (only 78,000 tons in 1955), that territory has a rather good road system by African standards. This is explained in part by drier climate and by the existence of a dense rural population, which permits the employment of many workers on local road maintenance.

The Ten-Year Plan[51] included a program designed mainly to provide trans-Congo highways rather than feeders to river and rail routes. In the revised plan, however, this program was heavily curtailed and the allocation of total expenditures devoted to road transport was reduced from 24 to 13 percent. In 1955–56, the only major road construction being carried on was on the Stanleyville–Bukavu highway.

The establishment of effective commercial trucking services has been discouraged by prevailing road conditions. Yet it has repeatedly been recommended that trucking should play a much more important role in Congo transport.[52] Some roads are excessively narrow, as the main road up the Kamaniola escarpment to Bukavu; others have an inadequate base to withstand heavy traffic. The high cost of imported fuels is also a prohibitive factor. Nevertheless, some 15,500 miles of road feeder services are at present provided in the Congo (Fig. 12C).[53] The four leading motor haulers had a combined traffic of 364,600 tons and ton-mileage of 46,100,000 in 1955. Tonnages transported by other truckers are not recorded. Special mention should be made of the part played by large mining and agricultural concerns in the movement of Congo road traffic. They often maintain sizable fleets of trucks for short-distance hauls and are pioneer road builders.

Looking at the total transport picture of the Congo, it may be concluded that the basic pattern of territorial freight movement has probably been set for many years ahead, and that the magnificent if somewhat capricious and at times frustrating Congo system of waterways will continue as the backbone of regional transport. Rail transport will remain the chief mover of bulk minerals from the Katanga, while motor transport should greatly increase in local importance and in the difficult eastern area. Possibly the most important alteration in traffic flow would result from completion of the proposed line linking Leopoldville with the Bas Congo–Katanga system.

COMMODITY FLOW TOWARD MATADI

Table 2 reveals that oil palm products, cotton, coffee, lumber, and certain minerals constitute about 85 percent of Matadi's export tonnage. The areas producing these commodities are shown in Figure 17A–E. It is not possible to break down the imports of Matadi by destination except for petroleum products, which are shown in Figure 17F.

Oil Palm Hinterland

Oil palm products—palm oil, palm kernels, palm kernel oil, and oilcake—are the leading agricultural exports of Belgian Africa. In 1955 their total export tonnage was 280,732, about 20 percent of the total export tonnage, and their total export value was $43.5 million. The Congo vies with Indonesia for second place among world exporters of palm oil, Nigeria being the premier world exporter of both palm

[50] See J. P. Delecourt, "Transport par Route au Congo Belge," *Journées d'Études des Transports*, *op. cit.*, pp. 95–106.

[51] *Plan Décennal . . .*, *op. cit.*, pp. 140–56.

[52] E. J. Devroey, *Réflexions sur les Transports Congolais à la Lumière d'une Expérience Américaine*, Institut Royal Colonial Belge, Mémoires, Section des Sciences Techniques, Vol. V (1949), No. 4.

[53] By Vicicongo and "Shun" (*Société du Haut Uélé et du Nil*) in the northeast; M.A.S. (*Messageries Automobiles du Sankuru*) and "Transkat" (*Compagnie Générale des Transports au Katanga*) in the Katanga and Kasai; "Sotranscongo" (*Société des Transports et de Commerce au Congo Belge*) in the northwest, and Otraco on the 39-mile route between Kamaniola and Bukavu.

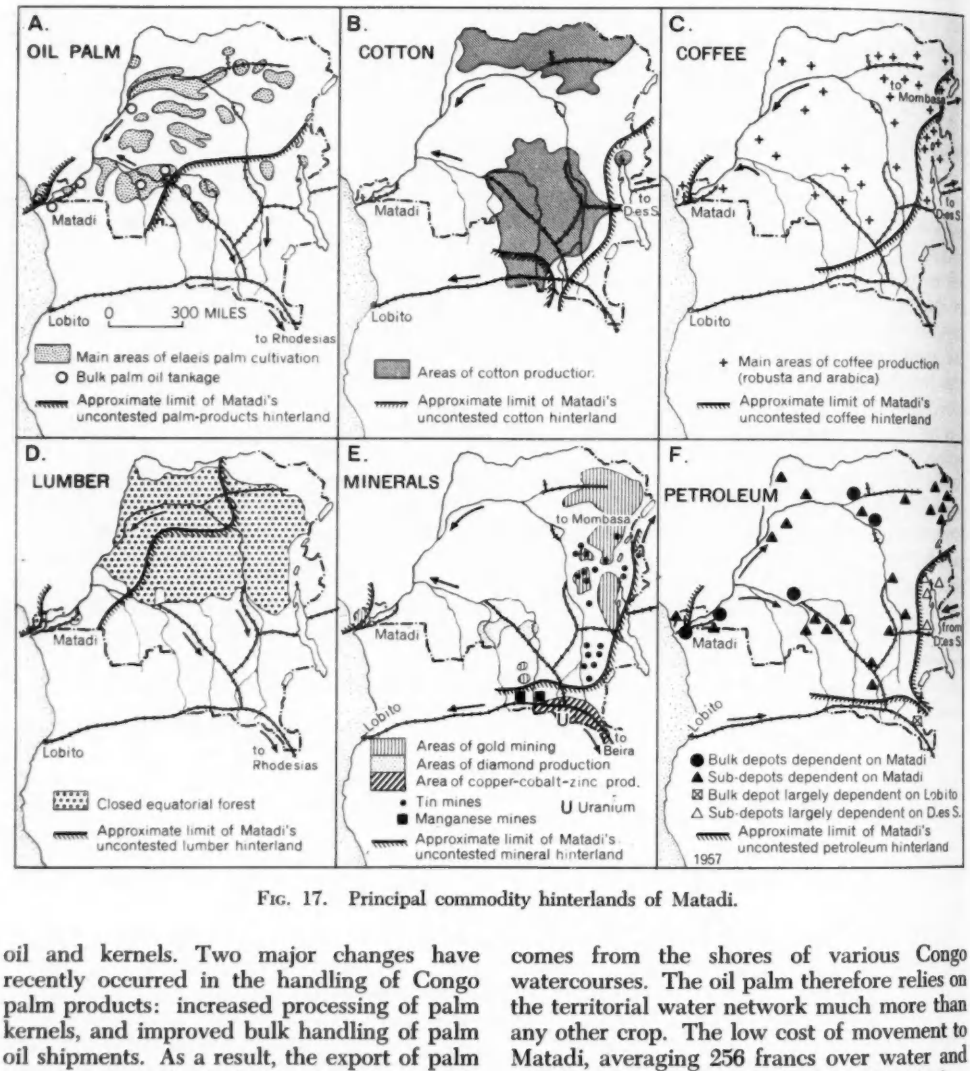

FIG. 17. Principal commodity hinterlands of Matadi.

oil and kernels. Two major changes have recently occurred in the handling of Congo palm products: increased processing of palm kernels, and improved bulk handling of palm oil shipments. As a result, the export of palm kernels is steadily declining, though it is still sufficient to have justified the installation of mechanized kernel-handling facilities at Matadi in 1955. The second change has involved the construction of tanks and fluid-loading equipment both at Leopoldville and Matadi–Ango Ango.

Almost three-quarters of the total European oil palm plantation area is in Leopoldville and Equator provinces. About half of the African plantings are also in this area, while most of the palm fruit gathered by Africans from "wild" stands and sold to European oil mills comes from the shores of various Congo watercourses. The oil palm therefore relies on the territorial water network much more than any other crop. The low cost of movement to Matadi, averaging 256 francs over water and 135 francs over the Matadi–Leopoldville line per ton of oil in 1955,[54] has probably been the outstanding factor in encouraging oil palm production for overseas export. In areas where ecological conditions are just as desirable, but where water transport is not available, output is restricted. Produce shipped from these areas moves to the soap factories at Elisabethville or to markets in British Central Africa (Fig. 17A).

Moving from company-owned, riverside

[54] Information supplied by Director, H.C.B., Leopoldville, May 1955.

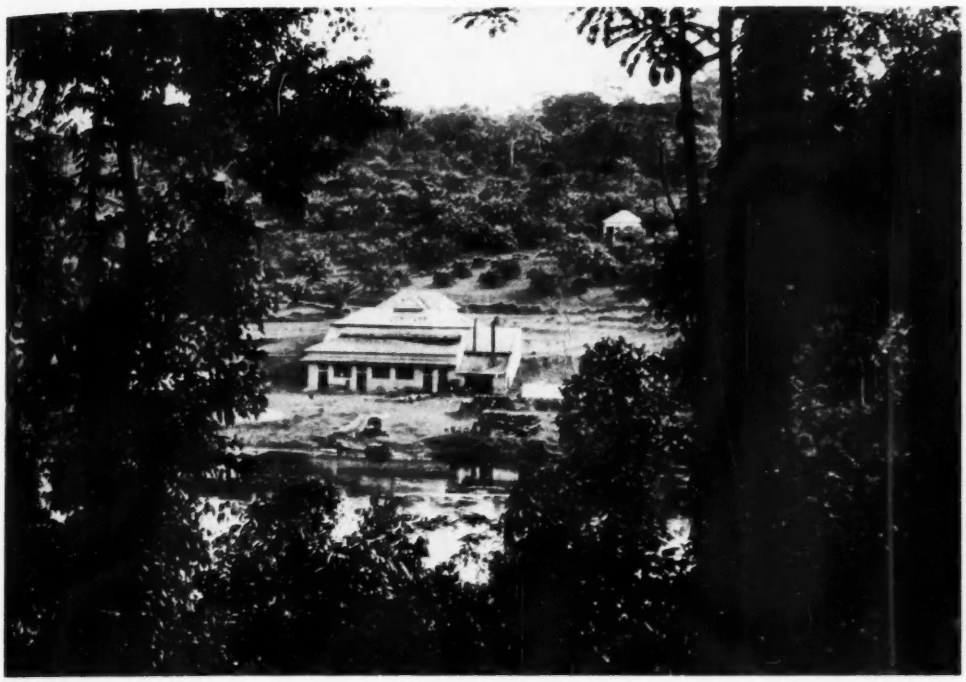

FIG. 18. Small mill on Kwilu River, processing regional palm fruit production and shipping it to Leopoldville by barge. (Courtesy Madail)

mills (Fig. 18), palm products are typically shipped by barge, via large Otraco collection centers to Leopoldville, where the largest producers (*Huileries du Congo Belge*, Amato Bros., Madail, "Colohuile") have their receiving installations. *Huileries du Congo Belge* formerly had its own river fleet, but this has been taken over by Otraco. The output of smaller producers is normally absorbed by the large firms or marketed under their sponsorship, such as the "Congopalm" cooperative organized by H.C.B. At Leopoldville the oil is transferred to company tank cars and moves over the rail line to Matadi–Ango Ango, where it is received in company tank farms which generally store about one month's supply to ensure the loading of ships without delay. Kernels are moved in open hopper cars and stored in lighters at the seaport.

Cotton Hinterland

Cotton is produced mainly in the drier savanna areas of the Congo and is therefore not so well served by the waterways of the country. The Congo ranks after Egypt, the Sudan, and Uganda among African cotton producers. It exported 41,325 tons of cotton valued at $32 million in 1955. Raw cotton is chiefly portered or carried on bicycles (Fig. 19) to the European ginneries from which it is trucked to rail and water routes. Several of the large haulers began as cotton movers and the relation of road services to cotton-producing areas is still apparent (compare Fig. 4B and Fig. 17B).

About a fifth of the fiber is ordinarily consumed in the mills of "Utexleo" at Leopoldville which markets its cloth in the Congo. Overseas exports move via Matadi, where a special conveyor belt at the *Quai de Venise* loads bales into barges for storage and later shipment. Recently, cottonseed-oil and oil cake have also been exported via Matadi in increasing tonnages (about 30,000 tons in 1955). Fiber from around the northern end of Lake Tanganyika is largely consumed by a smaller textile mill at Albertville. A few thousand tons of cotton grown near the Angolan border are exported via Lobito.

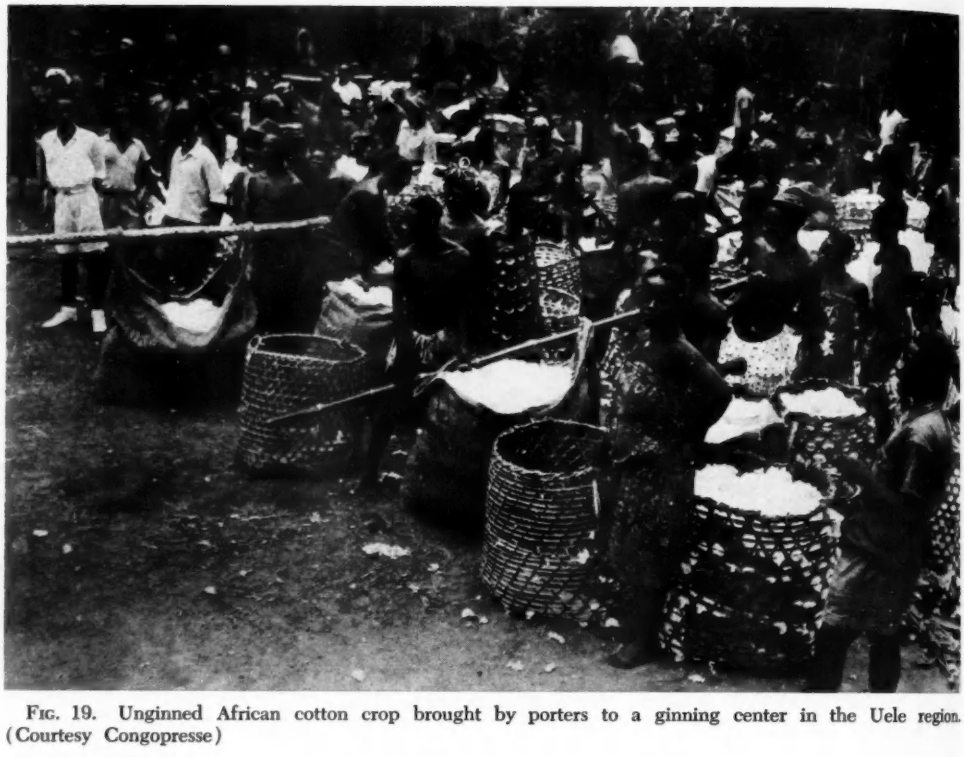

FIG. 19. Unginned African cotton crop brought by porters to a ginning center in the Uele region. (Courtesy Congopresse)

Other Agricultural Hinterlands

Production of coffee is more scattered than that of any other export commodity, many plantations being at great distances from the national seaboard (Fig. 17C). The exports of *robusta* and *arabica* coffee totalled 43,678 tons valued at $41 million in 1955. The valuable *arabica* variety is grown entirely in the highlands of the east and in Ruanda-Urundi. Coffee from the Lake Kivu areas has to undergo a 54-day journey with seven or eight transshipments, if it moves via Matadi; so much of the Kivu and Ruanda-Urundi coffee is shipped via Dar es Salaam and Mombasa. Only about half of the coffee exports move via Matadi.

Among the other agricultural commodities exported from Belgian Africa,[55] the outstanding product shipped through Matadi is *hevea* rubber, the tonnage of which is almost equal to that of coffee at the port and the value of which is almost half that of the cotton exported. Production, which has increased from about 1,000 tons before the war to 22,500 tons in 1954, is concentrated in the western half of the country. All latex exports move along the same waterways used for palm products and are shipped out from Matadi. Matadi also handles the country's moderate shipments of cacao, *urena lobata* and *punga* fibers, maize, manioc flour, and groundnut oil and cake. Much of the agricultural produce of the eastern margin of the Congo, including pyrethrum, essential oils, castor seeds from Ruanda-Urundi, and hides and skins from Kivu and Ruanda-Urundi, moves via the closer Indian Ocean ports despite special rates offered on the national route. Cinchona bark and salts, shipped principally to the United States for the production of quinine, are the only products from this area that normally move via Matadi. Tea, a relative newcomer in the

[55] See Table III, pp. 12–13, in Société Coloniale Anversoise, *Main Belgian Congo and Ruanda-Urundi Agricultural Products—Annual Review 1955* (Antwerp, 1956). More detail on Belgian African crops may be found in Belgium, Ministère des Colonies, Services de l'Agriculture, *L'Agriculture au Congo Belge et au Ruanda-Urundi de 1948 à 1952* (Brussels, 1954).

region, is largely absorbed in the Congo, though some is flown to the Chad territory of French Equatorial Africa as return cargo for shipments of meat.

The Timber Hinterland

Export of timber products is severely restricted by the great distance of most of the Congo forests from the sea and by the necessity for several transshipments. Although the Congo contains one of the largest areas of *selva* or rainforest in the world (Fig. 17D), totalling 240 million acres, logging operations cover only about 1.2 million acres. Eighty percent of exports, which totalled 167,000 tons in 1955 or three times the prewar level, originate in Mayumbe.[56] The U.S. Plywood Corporation has a large plant in this area, using primarily *limba* (*Terminalia Superba*), the veneer of which is marketed in the United States as "Korina." A government decree in July 1955 placed partial restrictions on *limba* exports to protect the species.

The Mayumbe region ships about half of its lumber exports via Boma and half via Matadi, to which logs are carried by 7–10 ton diesel trucks. Some sawmilling occurs along the Matadi–Leopoldville line, which permits relatively low-cost movement to the port, but most of the lumber felled in the inland Congo basin is consumed within the territory. Lumber produced in the Lake Leopold II and Stanleyville regions, however, is shipped to Leopoldville mills by steamer, barge, low-draft pontoons and in rafts, and is partially exported as veneers and plywood.

The Mineral Hinterland

Most of the mineralized areas[57] of Belgian Africa are found at great distances from the seaboard (Fig. 17E), requiring early beneficiation and refining to permit economic movement to the ports.[58] The development of hydroelectric facilities in the Katanga has been in response to this necessity. The first copper smelter was constructed at Lubumbashi (Elisabethville) in 1911; a second plant with electrolytic refining facilities was completed at Shituru (Jadotville) in 1929. Tin smelting followed at Manono in 1935, reduction of cobalt at Shituru in the forties, and zinc smelting at Kolwezi in 1953. Production of ferromanganese is now being studied. Although increased electrical supplies have permitted the installation of some refining plants, a large part of Belgian African minerals are only concentrated or smelted in the Congo and are further refined at the Hoboken (Antwerp) and Olen (Campine) metallurgical plants of *Union Minière*.

The combined volume of Belgian African mineral exports represented about half of total tonnage exports in 1955. The desire to avoid expensive transshipments plus special rates offered to mineral producers on extra-national lines have meant that a substantial portion of mineral output moves via Lobito and Beira.[59] In 1955, Matadi handled 90,251 tons of copper from a total Congo export of 230,790 tons. Copper shipments from the Congo via Beira were 70,456 tons, and via Lobito 45,090 tons. Lobito handled practically all cobalt products (some 12,200 tons), cadmium (157 tons) and germanium ores, and manganese ore (274,494 tons) which is mined near the line connecting with the Benguela Railway. Half of the zinc concentrates (103,074 tons) and almost all of the zinc metal exported (33,228 tons) also were shipped either via Lobito or Beira. Only uranium concentrates from Shinkolobwe (some 2,500 to 6,000 tons a year) and various wolfram ores followed the national route to Matadi, security being a factor for the former.

The other mining concerns in Belgian Africa are not so well served as *Union Minière du*

[56] See Belgium, Ministère des Colonies, Service de l'Agriculture, *L'Exploitation Forestière au Congo Belge*, by L. E. Eeckhout (Brussels, 1953).

[57] See A. Marthoz, *Industrie Minière et Métallurgique au Congo Belge*. Académie Royale Coloniale Belge, Mémoires, Section Sciences Techniques, Nouvelle Série, Vol. I (1955), No. 1; M. Robert, *Géologie et Géographie du Katanga y Compris l'Étude des Ressources et de la Mise en Valeur* (Brussels, U.M.H.K., 1956); *Union Minière du Haut-Katanga: Monograph 1954* (Brussels, U.M.H.K., 1955).

[58] In 1955 some 9.2 million tons of mineral ores were extracted in the Katanga alone, but after processing only 655,000 tons were exported. R. Wautelet, "Transports Miniers au Katanga," *Journées d'Études des Transports, op. cit.*, pp. 443–47.

[59] See Hance and van Dongen, "Beira, Mozambique Gateway to Central Africa," *Annals*, Association of American Geographers, Vol. 47 (1957), pp. 307–35, and "The Port of Lobito . . . ," *op. cit.* In 1955, the Limpopo Railway made a second Mozambique port available for Katanga shipments. See Hance and van Dongen, "Lourenço Marques in Delagoa Bay," *Economic Geography*, Vol. 33 (1957), pp. 238–56.

Haut-Katanga by through rail facilities and have relied primarily upon the national route. A small tonnage of cassiterite from Ruanda does move to Mombasa and some gold from northeastern Congo is flown to Europe. But the tin producers have had to use the circuitous Lualaba–Congo route involving multiple transfers (for 17,500 tons of cassiterite and about 2,500 tons of tin metal in 1955). "Symetain," the leading tin mining producer, has a particularly remote location between the Lualaba and the Lakes and has to maintain a fleet of 100 trucks to haul its output to Kindu. "Geomines," the second ranking producer, also trucks its metal and concentrates from Manono to the river at Muyumba.

The large gold mines of "Kilo-Moto" in the Watsa area and at Kilo produce 60 percent of the Congo's refined metal. These mines and other scattered smaller producers have similar transport difficulties occasioned by the remoteness of their mining areas, but these difficulties are more restrictive in bringing in supplies than in moving the concentrated, high-value gold ingots to market. The important diamond production of "Forminiere" at Bakwanga and Tshikapa in Kasai province is in a somewhat better position and the pending improvement of the waterway above Charlesville on the Kasai should further benefit their inward shipments. Diamond exports are made by air. Other Belgian African minerals, such as limestone and coal, typically move only short distances within the country.

Because of the use of foreign outlets for shipment of minerals there has been no necessity to equip Matadi with special handling facilities, such as those for Rhodesian chrome ore at Beira or for Congo manganese at Lobito. Copper ingots are stored at Matadi in open yards, zinc concentrates and cassiterite in barges (cf. Fig. 4). If the link between the Bas Congo–Katanga and the Matadi–Leopoldville line is effected, resulting in an increased mineral flow to Matadi, some mechanized loading gear would probably be required.

The Petroleum Imports Hinterland

The consumption of petroleum products in Belgian Africa has grown with great rapidity, stimulated by the postwar boom, the great increase in vehicles, dieselization of the railways and river fleet, and increased air services. Imports of petroleum products have expanded from 40,000 metric tons in 1939 to 431,444 tons in 1955, with about a third coming from the United States. About four tankers a month discharge at Ango Ango, where facilities for storage have been quadrupled since prewar years. The old 243-mile, 4-inch pipeline is still used in transmitting gas-oil to Leopoldville but is to be replaced by a 12-inch line in 1960. A 6-inch line for gasoline was opened on a 218-mile route to Leopoldville in 1953.[60] Aviation gasoline and kerosene are railed in bulk between the Matadi and Leopoldville Socopetrol terminals, while containers of lubricants are railed as general cargo.

At Leopoldville most of the fuels are put into drums and cans for shipment upriver (Fig. 20), though some move in tank barges to bulk depots at a few key points. From these bulk depots and other sub-depots which handle only drums and cans, oil products are distributed to their final destinations by Petrocongo, Texaco, Socony-Vacuum, Shell, and their sub-agents. Prior to 1950 limited bulk storage was available among inland points only at Aketi, Stanleyville, and Charlesville (Fig. 17F). Bulk facilities have since been erected at Elisabethville (2,500 cu.m.), which is largely supplied via the Benguela Railway. In 1954 imports of petroleum fuels via Lobito were one-twelfth of total petroleum imports. However, Socopetrol installed in 1955 a 10,000-cubic-meter depot at Port Francqui in an effort to draw the important Katanga area into the orbit of Matadi.[61] This bulk terminal is also intended to serve the needs of Albertville via the Kamina–Kabalo route, and of Usumbura and Ruanda-Urundi using tank cars and then tankers on Lake Tanganyika. These areas have been largely served by Dar es Salaam, but proposals included in the Ten-Year Plan to improve facilities at the "Belbase" of Dar es Salaam and of Kigoma may be abandoned in favor of the national route.

[60] In 1955 the quantity of fuels transmitted by pipeline was estimated at 337,000 cubic meters. G. Gouvaerts, "Les Carburants au Congo Belge," *Journées d'Études des Transports, op. cit.*, pp. 491–94.

[61] Discovery of petroleum in Angola in 1955 and completion of a refinery near Luanda in 1958–59, designed to supply both Angola and the Congo, may strengthen the Benguela way in the supply of liquid fuels to the Katanga, because the route is more direct and because both the Angolan oilfields and the old terminal belong to the same Belgian financial interests, Petrofina.

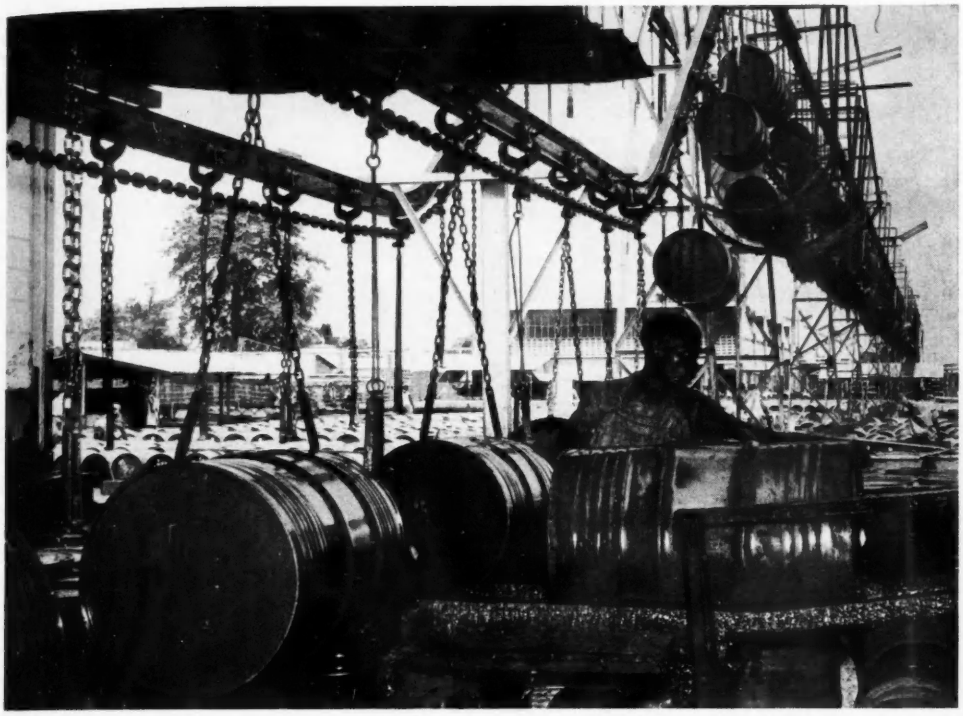

FIG. 20. "Socopetrol" terminal at Leopoldville, where the upriver shipments of liquid fuels originate. (Courtesy Congopresse)

Just how realistic the proposed new routing is, or how much protection it will require, remains to be seen.

Similar efforts to improve the distribution of petroleum products in inland areas involve enlarging bulk storage facilities at Stanleyville (to 5,500 cu.m.) and Aketi (to 11,000 cu.m.), as well as the tank-barge fleet on the Congo. Although prices of fuels are regulated in favor of remote regions, a drum of gasoline selling for $21 in Leopoldville costs $30 in Bukavu (Fig. 21).

Other Hinterlands of Matadi

Some coal is imported via Matadi and is moved chiefly to Leopoldville. But Lobito is the main port of entry for coal destined to the Katanga, the major coal-consuming province. This area also uses about 500,000 tons of low-grade domestic coal from Luena and coking coal from Wankie in Southern Rhodesia. As has been noted, Matadi plays a dominant role in the import of processed goods and manufactured goods, though extra-national ports have slightly increased their share in this traffic. These are important in the movement of heavy machinery and railroad equipment, for which there is a strong incentive to reduce the number of transshipments. Cement imports via Matadi were once very large but have declined with the construction of domestic cement plants.

Matadi has importance as a passenger port only for the area around Leopoldville. Ship passengers are predominantly Europeans, as Africans do not as yet move in any numbers in and out of the colony. For the rest of Belgian Africa which can be reached by surface transport only at the cost of multiple delays at transfer points, travellers prefer the air services of Sabena and Sobelair or the quicker rail routes between Lobito and the Katanga, and between Dar es Salaam and the eastern regions.

THE FUTURE OF MATADI

The problem of competition from foreign routes has always dominated the transport

FIG. 21. Bukavu, the center of European settlement in the eastern highlands of Belgian Africa, on the shores of Lake Kivu. More than any other important Congo agglomeration it suffers economically from the long distance (2,060 miles) which separates it from the national port of Matadi. (Courtesy Congopresse)

economy of Belgian Africa. There have been two schools of thought in Belgium regarding Matadi. The first has advocated development of the port regardless of the capital expenditure involved and the imposition of rates designed to focus traffic on the *Voie Nationale* regardless of real operating costs. The second, no less animated by the spirit of national welfare, has considered the use of extra-national gateways as the most rational solution to the particular problems of Congo transport. E. J. Devroey, Honorary Chief Engineer of the Colony and proponent of the second school, writes (translation by the authors):

> It would be a dangerous illusion to imagine that all the traffic of Congo will continue to move indefinitely by the Matadi bottleneck.
>
> The conception of the national route is uneconomic and contrary to geography. It is no longer appropriate in these times of international cooperation in central Africa.
>
> The rational hinterland of Matadi can scarcely extend to more than half of the territories under Belgian influence in Africa, the remaining area must naturally turn to other windows open to the sea: Lobito, Dar es Salaam, and Beira, even Port Sudan.[62]

[62] "Possibilités d'Emploi de Télépherique au Congo Belge," *op. cit.*, p. 236.

Other ports should rightfully be added to this list: Lourenço Marques, since mid-1955 an alternate outlet to Beira; Mombasa, through the extension of the Uganda line to Kasese; and Luanda, which could be tied to the Congo railways from its rail system which is now being extended in two lines toward the Congo borders.[63]

The partisans of *Voie Nationale* have been temporarily quieted because of the near saturation of the Leopoldville–Matadi route, which forced the increased use of foreign ports. Their voices are likely to be heard again when the Kala Kala quay is completed. But the new berths will rapidly become just as crowded if the present pace of development in Belgian Africa continues. The question must soon be faced whether it is worthwhile to expand Matadi further despite the great difficulties of the site or whether some of the extra-national routes should not be willingly accepted as natural gateways of the Congo.

[63] See Hance and van Dongen, "Port Development and Rail Lines in Portuguese West Africa," a paper presented at the XVIIIth International Geographical Congress, Rio de Janeiro, August 1956.

HSIA-KE HSU – PIONEER OF MODERN GEOGRAPHY IN CHINA[1]

CHIAO-MIN HSIEH

The Catholic University of America

WESTERN histories of the study of geography have up to now paid virtually no attention to the development of this science in Asia. Yet there have been prominent geographers and one of these in China was Hsia-ke Hsu (1586–1641). Hsu's real name was Hung-tze, but he was better known in China by his surname Hsia-ke.

During the period from the fifteenth to the seventeenth centuries, many important explorations in human annals were performed. Much has been written about Henry the Navigator, Christopher Columbus and other such outstanding figures, but Hsia-ke Hsu's geographical discoveries are less well known than the European explorers who were his contemporaries.

While Hsu was the most important Chinese explorer of his day, he was not the earliest Chinese traveler of note. All the earlier Chinese explorers and travelers had set out for political or religious reasons, but Hsu's motives for traveling were unique. Chang chien was the first known Chinese traveler who, as envoy of the Han Emperor Wu-ti, journeyed as far as Bokhara in what is now Soviet Middle Asia in 126 B.C. Fa-hsien and Hsuan-tsang were two Buddhist monks who were inspired to go to India, the birth place of their religion, in 399 and 629 A.D., respectively. The first Chinese to travel widely by sea was Cheng ho, commander of seven expeditions between 1405 and 1431, who was sent by Emperor Yunglo, and was the first Chinese navigator to cross the Indian Ocean. Sent neither by emperor nor by God, Hsu was the first Chinese to make long treks in the interest of scientific discovery and geographical investigation. His lively curiosity led him to roam over a large part of China and endure for years the hardships of travel to find the answer to the questions that would not be dismissed from his inquiring mind.

It is also interesting to note that the age in which Hsu lived was the period when the natural sciences were just beginning to emerge. Among his European contemporaries were such brilliant thinkers as Francis Bacon

FIG. 1. Portrait of Hsia-ke Hsu

[1] The author has personal interest for writing about Hsu. First, he grew up in the Yangtze delta, where Hsu lived over three centuries ago. Secondly, the author traveled from Chekiang via Kiangsi, Hunan, Kwangsi to Kweichow province when the National Chekiang University, which he was attending, was forced to move inland as a result of the Japanese invasion during the Second World War. Thus he passed through approximately the same regions that Hsu visited in the 1630's; except that Hsu finally traveled to Yunnan plateau to investigate the source of the Yangtze, while the author went to Szechuan basin to join the Institute of Geography of China. Although his motives for making this journey were quite different from Hsu's, his method of traveling was much the same as Hsu's. As a student of geography, the author was able to observe many of the phenomena which Hsu described in his diary.

This paper was presented by title at the annual meetings of the Association of American Geographers at Memphis, April, 1955. Kenneth J. Bertrand, Norma Farquhar, and Jerome P. Pickard kindly read the manuscript and offered helpful suggestions.

(1561–1621), Johannes Kepler (1571–1630), and Galileo (1564–1642), all of whom helped to lay the foundations of modern science. Paralleling the scientific awakening in Europe, there were at the time a number of ingenious Chinese scholars who probed into scientific matters. Shih-chen Li compiled a comprehensive herbal or *materia medica* in 1578; Ying-hsing Sung wrote a well-known illustrated work on various industries in 1637, and Tsai-yu Chu published a monograph containing new observations on music in 1610. Kuang-chi Hsu, who studied under and collaborated with the Italian Jesuit Matteo Ricci (1552–1610), compiled an important work on agriculture. After the coming of the Jesuits to China in the sixteenth and seventeenth centuries, Chinese science gradually began to fuse with that of the rest of the world.[2] Thus Hsu lived and explored at a time when the bounds of knowledge were being extended in every field.

A SHORT BIOGRAPHICAL SKETCH

Before going into the details of Hsu's travels it is fitting to say a few words about his family background and formative years. Hsu was born in 1586 at Kiangyin, Kiangsu, into a family of wealth and education. His ancestors were noted for their knowledge of the classics, and Hsu, even as a youth, attracted attention because of his excellent memory, his writing ability and his interest in history, geography, maps, and accounts of explorations. He received a good classical education, and as a writer he enjoyed literary fame in his own time. Many of his friends were also famous men of letters. A few specimens of Hsu's poems show a vivid imagination and a keen sense of human love. Moreover, from the preserved fragments of his writings, we can see that his calligraphy is quite beautiful and graceful. When Hsu was nineteen years old, his father died, but his mother lived on for many years. Hsu married and had several children, but even a family could not keep this restless wanderer at home. In spite of all the advantages that his comfortable family had to offer, Hsu abandoned the conventional course of taking the state examinations and entering upon an official career, preferring instead a life of travel, exploration, and writing.

[2] Joseph Needham and Wang Ling, *Science and Civilization in China* (London, 1954), Vol. 1, p. 149.

Hsu's travels began in 1607, when he was twenty-one, and continued until his death at the age of fifty-five. In his earlier years he visited the five sacred mountains of China and many famous lakes, setting foot in the provinces of Hopei, Shantung, Shansi, Kiangsu, Chekiang, Fukien, and Kwangtung. His ambition, however, was to see the little-known southwestern part of China. In 1624 his mother died, an important event, for according to the Chinese principle of filial piety, one should not travel too far away from one's aged parents. Significantly, Hsu made his greatest expedition after the death of his mother.

On this expedition Hsu was accompanied by a servant and a Buddhist monk who wanted to deposit a copy of a sutra in a temple at Chitsu shan near Tali in Yunnan. The monk had copied the sutra in his own blood—an act of devotion not uncommon at that time. This trek, which lasted four years, resulted in important discoveries, but it also brought Hsu much hardship and suffering. The monk died when they reached the interior part of southwestern China and the servant deserted. The injuries and fatigue Hsu endured in those four years were no doubt largely responsible for his death a few months after he returned home.

One may ask how Hsu was able to support himself while traveling in these remote areas. When he started out, he was well provided with money, but on the Hsiang River he was attacked by pirates, lost all he had, and narrowly escaped drowning. Through the patronage of Prince Kuei in Hengchow he was able to continue his exploration. In Kweichow he was twice robbed and reached Yunnan penniless. However, he had the good fortune to meet a local scholar who did all he could to help him. When he was in Yunchang he lost his purse during one of the steep climbs and had to endure many days of hunger, finally being forced to pawn his outer garments. Getting thoroughly wet, having little food, and being miserably sheltered were his everyday experiences. Occasionally he was provided with a pony, but most of the time he went on foot, and more than once he had to carry his own baggage.

HSU'S TRAVELS

On Hsu's earliest travels he explored his native province, Kiangsu, and the neighbor-

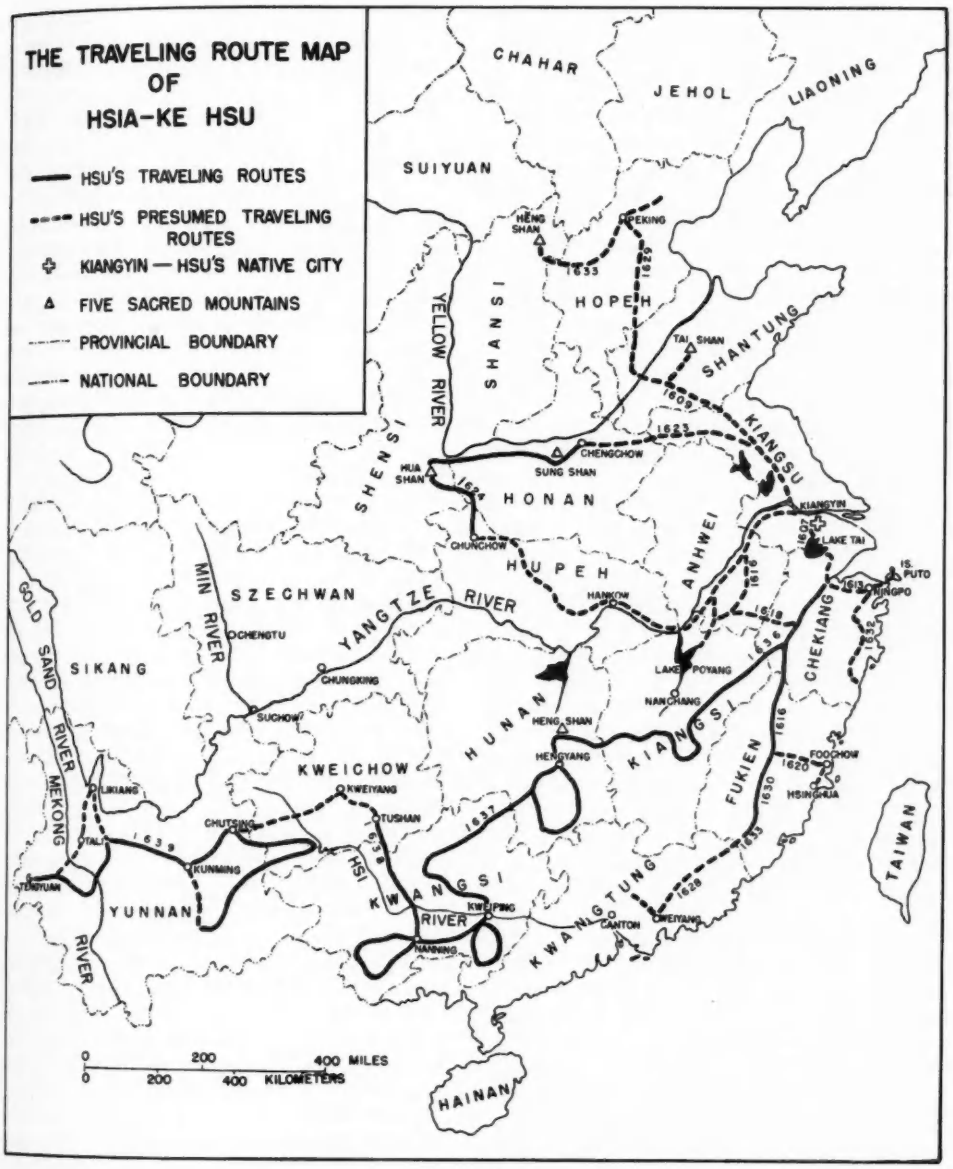

FIGURE 2

ing coastal provinces to the north and south, Shantung and Chekiang (Fig. 2). Setting out in 1607, he hiked to Lake Tai on the Kiangsu–Chekiang border, and climbed all the hills in the vicinity. Two years later he went north to Shantung and Hopei provinces and visited Tai shan, the eastern sacred mountain and home of Confucius, and also reached Peking, the capital of the country. Heading southward in 1613 he made a pilgrimage to Puto island near Ningpo, and thence continued southward to the mountains near the Chekiang coast.

In 1616 and 1618 he ventured inland to the provinces of Anhwei and Kiangsi where he

climbed the noted mountains and then proceeded inland to Lake Po-yang. Hsu's first visit to Fukien province was in 1616 when he roamed in the northwestern part of the province; in 1620 he explored the southeastern part, passing through Foochow and stopping at the waterfall of Hsinghua. Hsu had thus traveled most of the coastal provinces from Hopei in the north to Fukien in the south by the time he reached his early thirties.

In 1623 Hsu set out upon a trek which was to take him farther from home than had any of his previous journeys. Heading northwestward into the interior province of Honan, he passed through Chengchow and went on to Sung shan, the central sacred mountain, stopping to spend several nights on its summit. Then proceeding westward he arrived in Shensi province where he ascended his third sacred mountain, Hua shan. From there in the following year he went southward to Hupeh province, and near Chunchow climbed Wutang shan, a peak well known to Taoists. Hsu made a total of five trips into Fukien. In addition to 1616 and 1620, he made subsequent visits to Fukien in 1628, 1630, and 1633. In 1628, he even penetrated into Kwangtung province to visit Lofu shan near Weiyang.

Before commencing the important exploration to the southwest, Hsu made another excursion northward. In 1629, he revisited Peking and in the summer of 1633 he went to northern Shansi where he visited Hĕng shan, the northern sacred mountain.

Setting out with one servant and a Buddhist monk as companions, Hsu began his most extensive journey on September 19, 1636, at the age of fifty. His purpose was to explore southern and southwestern China and to study the mountains and rivers of that area. He was especially interested in finding the sources of the Yangtze and Hsi (West) rivers.

The route followed by this trio took them through the southern and southwestern part of China, including the provinces of Chekiang, Kiangsi, Hunan, Kwangsi, Kweichow, and Yunnan. Starting from Chekiang, they traveled southwestward and passed south of Nanchang, the capital of Kiangsi, and arrived at Henyang in Hunan province.

While in Hunan Hsu visited the southern sacred mountain, Heng shan; thus Hsu was one of the very few Chinese who had the good fortune to see all five of China's sacred peaks. Hsu had seen the highest peaks in Kiangsi and Hunan, and the knowledge he gained thereby proved helpful when he later undertook to study the divide separating the waters of the Hsi River from those of the Yangtze Valley.

Proceeding into Kwangsi, Hsu made a point of observing all the important rivers of the province. He and his two companions reached Nanning by way of Kweiping. From Nanning they traveled westward and then returned again to Nanning in the autumn of 1637. It was here that the monk died. His last wish was to be buried with his sutra at Chitsu shan, a peak famous to the Buddhists, near Tali in Yunnan, and Hsu decided to carry out this request at all costs. Thus he carried the ashes of his friend with him for almost a whole year until at last he was able to fulfill the monk's dying wish.

On his way to Chitsu shan, Hsu traveled in Kwangsi, Kweichow, and eastern Yunnan in 1638. Leaving Nanning, he and his servant went northward by way of Tushan to reach Kweichow. Hsu made a comparatively short stay in Kweichow, but he explored thoroughly the eastern part of Yunnan, passing through Kweiyang, the capital of Kweichow province. Hsu finally arrived at Kunming in the autumn of 1638. He remained at the latter place only a brief time before going on to visit the Chinsha-Kiang (Gold Sand River). Early in 1639 he reached Chitsu shan, where he buried the ashes of his monk friend.

From spring to autumn of 1639 Hsu roamed about western Yunnan, pursuing his study of rivers—the Mekong, Salween, and Yangtze. Leaving Chitsu shan to go northward, he reached Likiang in the spring and intended to go into Tibet, but failed because of local disturbances. Returning from Likiang, he trekked southward through Tali, crossed the Mekong River and then traveled westward to Tengyueh in western Yunnan. While in Tengyueh he intended to enter Burma, but failed. Nevertheless he was able to explore the country west of the Salween River and returned along the lower course of the Mekong. In the autumn of that same year he returned to Chitsu shan in Tali.

Hsu remained at Chitsu shan for three months because of injuries to his feet. He used this rest period to write a local geography of the mountain. At this time his servant deserted him, stealing most of his few belong-

ings—an act of disloyalty which hurt Hsu deeply, for this servant had been his constant companion during the previous three years of arduous travel.

After completing the geography of Chitsu shan, Hsu fell ill and traveled homeward for 150 days by sedan chair and boat, luxuries he seldom indulged in when he was well. He arrived at home in the summer of 1640 and died in January of the following year.

Hsu's travels were all recorded in his diary until his second visit to Chitsu shan. Perhaps he discontinued writing because of illness or if he did keep a diary of his trip homeward, it may have been lost.

Since Hsu's orginial plan was to go from Yunnan to Tibet and return by way of Szechuan, some of his biographers claimed that he had visited Szechuan and Tibet. However, Ting has demonstrated conclusively that it was impossible for Hsu to have done so.[3]

HSU'S DIARY

As an explorer, Hsu attracts our attention not only because he covered great distances and endured much hardship, but also because he kept a careful diary of his travels. It must be remembered that he traveled nearly always on foot and carried almost no equipment. The beautiful composition and detailed accuracy of his diary is therefore all the more remarkable. Hsu's account is especially valuable since it was written day by day along his route rather than after he returned home; thus it is not a collection of memoirs written in retrospect as were the accounts of Fa-hsien and Hsuan-tsang.

Present-day scholars are also impressed by the spirit of inquiry manifested by Hsu's diary. He rejected traditional explanations of the arrangements of rivers and mountains and tried to discover the truth about these natural phenomena by seeing them with his own eyes. Most of Hsu's writing was empirical description, but he had such a rich power of analyzing the landform details that he was able to coin a systematic landform terminology which appeared in his diary.

Hsu's preserved diary contains entries for more than a thousand days, the later entries being more detailed than the earlier ones. At first he usually wrote only about the temples he visited and the peaks immediately surrounding them, but on his last trip, from 1636 to 1640, he recorded all his observations in full. Prior to 1636 he had written accounts of only 150 days totaling about 40,000 words; thus the entries under these earlier dates averaged only about 270 words per day. During his final four-year trip to southwestern China, however, he left records of about 700 days, amounting to nearly 450,000 words with an average of about 650 words per day. His diary therefore contains more details about southwestern China, especially Yunnan province.

Hsu's diary stands out as a remarkable document when one considers the circumstances under which it was written. Hsu took time each evening or upon reaching a stopping place to write down his observations from memory. The diary reads more like a twentieth-century field surveyor's notebook than the diary of a seventeenth-century traveler. Probably no topographical observations were ever written down so clearly and in such detail before the nineteenth century.[4]

Although Hsu's diary is sometimes dull reading, in other places it achieves great literary beauty. One should bear in mind that Hsu's diary is an unedited account published exactly as he wrote it, since he had no chance to polish it before his death.[5] Also, he had no idea that his diary would become a widely-read and useful source of information. In spite of these circumstances, it contains innumerable poetic passages describing the landscape. None of the vague phrases so common in Chinese literature enter his work. Indeed his precise and beautiful style of writing helped to save the diary from oblivion, because it came to be regarded as a *tour de force* in literature, and it was actually printed as a model for composition. Hsu's diary will live not only as an early scientific document, but as a classic of Chinese travel literature.

As to the accuracy of the diary, there can be no question. One can even plot a rough map on the basis of his description alone. When the author traveled in Kweichow and Kwangsi provinces, he found Hsu's accounts astonishingly correct despite the fact that Hsu had no compass nor other instrument of any kind.

[3] V. K. Ting (i.e., Wen-chiang Ting), "On Hsu hsia-ke (1586–1641) — Explorer and Geographer," *The New China Review*, Vol. 3, No. 5 (Shanghai, Oct. 1921), p. 330.

[4] *Ibid.*, p. 332.

[5] *Ibid.*, p. 333.

HSU'S CONTRIBUTIONS TO GEOGRAPHY

Hsu's main contributions to geographical knowledge may be summarized as follows: his discovery of the sources of many rivers in southwestern China, his initiation of the study of mountain geography in China, his diary which served as a source for map compilers and surveyors, and his introduction of field work in Chinese geography.

Hsu's Discovery of the Sources of Many Rivers in Southwestern China

One of Hsu's greatest accomplishments was his discovery that the true source of the Yangtze River is the Chin sha Kiang (Gold Sand River). Previously it was believed that the Yangtze had its source in the Min River. Hsu wrote an elaborate essay on the origin of the Yangtze, but this essay unfortunately is lost; only an extract of it has been preserved in his native *Fang Chih*. Ting translated it in part as follows:

> The Kiang [Yangtze River] and the Ho [Huang Ho or Yellow River] are the two principal rivers; one in the north, the other in the south. My native district [county] happened to be situated near to the latter's entrance into the sea; hence the name Kiangyin. Those who are born and brought up there realize the greatness of the Kiang but not its length. Its source has always been supposed to be the Min Kiang. The explorers of the Ho agree that it rises in the mountains north of Kuenlun. It must be ten thousand *Li*[6] from the Min. How is it that the Kiang has a so much shorter course? Is it because the Ho is much larger than the Kiang? When I saw the Ho for the first time, its width was only one-third that of Kiang! Is it possible that the larger Kiang has a smaller drainage? After I had travelled in the north, the south and the west, beyond Shihmen and Gold Sand River, I then realized the Ho drains only five provinces, while the Kiang drains eleven. No wonder the Kiang is larger. Let us study their sources. The Ho begins in the north of Kuenlun, the Kiang in its south, and the two rivers are practically equal in length. The northern Ho flows northward; after passing Chishih, it begins to turn east to enter Ninghsia and the Ordos; then it turns south to Lungmen and finally joins the Wei. The southern Kiang at first is known as Liniushih, flowing southward, and passing the Shihmenkuan, it begins to turn east at Likiang to become the Gold Sand River. It turns again in the northern direction and joins the Min Kiang at Hsuchow, to become the Takiang [big river]. Now the Min Kiang passing Chengtu to Hsuchow is hardly 1,000 *Li* long, while the Gold Sand River passing through Likiang, Shihmen, Yunnan, Tungchuan to Hsuchow is at least 2,000 *Li*. Why regard the shorter one as the source of the Kiang? . . . Besides, south of Min there is another river named the Tatu Ho, coming down from Tibet, and joining the Min to the northwest of the Gold Sand River. Its source is also longer than the Min but not so long as the Gold Sand River. Hence the last alone must be regarded as the true source of the Kiang.[7]

Hsu wrote this essay at least a century before the western missionaries drew up their map of China by order of Emperor Kang-hsi (reign 1662–1722) of the Ching dynasty. Yet the European writers of the nineteenth century confidently declared that the Chinese never knew that the Gold Sand River was the Upper Yangtze.[8]

Hsu also recognized the true source of the Hsi or West River. According to the geographical beliefs of his day, the Pan River was the only source of the Hsi River and the Pan River had two sources, the Northern Pan and the Southern Pan, both of which originated in a mountain near Itzukung on the Yunnan-Kweichow border. Hsu paid a special visit to that mountain to trace the origins of the Northern and Southern Pan. He noted every tributary of the Pan River all the way from Chuching. At last he recognized that the Kotu River was the real source of the Northern Pan River. However, he incorrectly assumed that the waters of the Yanglin, Hsuntien, and Sungming rivers united to join the Kotu River. He also erroneously thought that the Southern Pan River was the upper portion of the Paise River. These mistakes were, as Ting pointed out, all reasonable guesses, and did not result from faulty observation.[9]

Hsu's last great discovery in Yunnan was his realization that the Mekong and Salween were separate rivers. Both the general geography of the Great Ming Dynasty and the local geography of Hsunming district depicted the Mekong and Salween as uniting into one great river somewhere below Yunchow. But Hsu maintained that the Salween must have a separate outlet to the sea, since in amount of water and width of stream the Salween seemed about equal to the Mekong. After many struggles and difficulties, he at last found the truth to be that the Hsunming River emptied into the Salween instead of flowing into the Mekong as the geographic books indicated in his day.

[6] One *Li* equals about one-third of a mile.

[7] *Ibid.*, p. 336.
[8] *Ibid.*, p. 335.
[9] *Ibid.*, p. 335.

Hsu as a Pioneer of Mountain Geography in China

Hsu's contribution to geography was not limited to rivers; he was also a pioneer of mountain geography in China. During Hsu's extensive explorations he traveled through a number of mountainous areas and made careful observations. On his early trips he visited the five sacred mountains of China and many high peaks along the southeastern coast, and in later years he climbed the Yunnan–Kweichow plateau. While traversing these mountain regions he carefully studied the drainage systems, rocks, landforms, climate, and vegetation, and tried to find the relationship between these phenomena and the latitude and altitude. Several passages from his diary are translated below to illustrate the fact that Hsu's keen observations were quite advanced for his time.

Upon reaching Yenping, Fukien, in February, 1628, he wrote the following note on the relationship between the steepness of the profile of a river and the distance of the divide from the ocean. It is surprising to find this basic principle of modern geology clearly expressed in an early seventeenth-century account.

> The stream of the Ningyang is ten times as steep and rapid as the stream of Chienchi because the latter, which starts from Pucheng and empties into the sea at Minan, is 800 *Li* long; while the former, which flows from Ningyang to Haicheng is only 300 *Li*. The shorter the course of the river, the more rapid the flow.[10]

An entry Hsu wrote in 1637, while visiting Nanning, Kwangsi, showed that he realized the lateral cutting force of running water:

> I passed through Hsiaotsun and as I entered the borders of Hsinning, the left bank of the river began to be nothing but rocky hills. When I arrived north of Hsinning, there were steep cliffs on the right bank of the river, facing the mountains opposite. The boat passed swiftly between the rocky peaks. . . . The river current erodes the mountains which are cut away to form a wall, and the current carries the debris away, depositing it either in the middle of the river or on the other side.[11]

In modern geological terminology, the cliff bank described above is called an undercut, while the other side of the bank is called a slip-off slope.

Hsu's description of rocks and rock formations were so precise that we can easily identify the objects he discussed. In 1628 Hsu traveled to Tengyuan, Yunnan, where he visited Taying shan, which is located in a crater of volcanic origin. Let us see how he described the pumice he found there.

> Now, the foot of the mountain is surrounded by water supplied by springs. The rock of the summit is orange-red in color and is composed of very lightweight material resembling a beehive; it looks as though it were formed of floating foam; thus even a chunk as large as a man can reach around can be lifted with only two fingers. The substance is very hard. Actually, this rock is the residue of burned ashes.[12]

While passing through Yentang shan, Chekiang, Hsu painted this verbal picture of the cliffs:

> I left the valley, and after proceeding for five *Li* I arrived at Lingyen Temple. Steep cliffs stood on all sides and seemed to touch heaven and cleave the earth.[13]
>
> Stratified rocks and strange peaks line the creek. The slopes of the peaks are as if carved artificially . . .[14]

The Yentang shan cliffs are composed of rhyolitic rock and are full of vertical joints. As erosion proceeded along these joints, these isolated peaks were formed.

Hsu's diary also contains vivid descriptions of the well-developed karst topography in Kwangsi and Kweichow. In these provinces there are a number of small enclosed basins which are drained by underground streams. Such formations are characterized by underlying soluble limestone beds arranged in horizontal layers. Although Hsu made many references to this karst topography, the following quotation, as translated by Ting, must suffice as an illustration:

> The rockiness of the mountains of Kwangsi keeps the streams clear which often flow underground in grottoes . . . the mountains of Lochuang are very rugged, and further east isolated peaks are seen, lined up one after another, reminding me of the scenery of Kwangsi. This strange forest of conical hills begins here and continues northeastward for many thousand *Li* till it reaches Taochow. It is [indeed] the marvel of southwestern [China].[15]

As the autor traveled from Nantan, Kwangsi, to Tushan, Kweichow, in 1940, he found many sinkholes, or dolines, in this region of massive limestone. Turning to Hsu's diary, he learned to his surprise that Hsu had also

[10] *Hsu Hsia-ke yu chi* (*The Travels of Hsia-ke Hsu*), edited by V. K. Ting (Wen-chiang Ting), (Shanghai: Commercial Press, 1928), Vol. 1, No. 2, p. 17.

[11] *Ibid.*, Vol. 1, No. 7, p. 2.

[12] *Ibid.*, Vol. 2, No. 16, p. 17.

[13] *Ibid.*, Vol 1, No. 1, p. 5.

[14] *Ibid.*, Vol. 1, No. 2, p. 30.

[15] Ting, *op. cit.*, p. 334.

noticed these features over three centuries ago. In March, 1639, while in Kweichow, he wrote:

> As I traveled from Nantan northward to the village of Patai, I entered into a rugged mountainous area and gradually came to a [relatively] uninhabited remote region. I proceeded five *Li* and passed Shanchiehling. Continuing northward for another *Li* I passed through the rocky defile of Chienpingling; the ridges were steep but densely forested, and the path was extremely rugged. This ridge forms the political boundary between Kweichow and Kwangsi as well as the divide between the drainage areas to the north and south. . . . When I had proceeded one *Li* northward along the valley, farm fields began to appear, and half a *Li* further, the valley turned north and broadened into a large basin. Another *Li* northward there was a village named Yui on the western slope. In these basins the surrounding walls are all high, and I do not know where the streams come from. However, at the foot of the rocky slope to the south of the village of Yui is a cave facing eastward, and a narrow creek empties into it from the fields. . . . I proceeded northward for another *Li* and again crossed a ridge and descended into an elongated valley in which there were rounded depressions. To the north and south there were ridges which had no clefts through which water could flow. The northern ridges were jagged like the teeth of a saw, and they were so steep that there was no room for a foothold.[16]

The round holes Hsu described are sinkholes or dolines, and the elongated valleys are groups of enlarged sinkholes which have become connected, while the saw-edged ridges are lapires.

As might be expected, there are many caverns in this limestone area of southwestern China. Some of these caverns had never been entered; so when Hsu bravely went in to investigate them, crowds of a hundred or so inhabitants of the locality would gather to watch him.

With regard to the relationship between vegetation and altitude, Hsu made numerous observations. For example, on April 13, 1613, after climbing Tientai mountain, he recorded:

> Returning again to Taipo, I followed the path to the top of the peak and found nothing but barren terrain and patches of grass. The mountain was high and the wind cold; but an inch of frost covered the grass, and the mountains on every side reflected the sunlight. Seen from this distance the gorgeous flowers and trees [below] presented a beautiful spectacle. On the slopes of the mountain the flowers were in full bloom, but on the summit there were no colorful blossoms because of the coldness at this altitude.[17]

[16] *Hsu Hsia-ke yu chi, op. cit.* Vol. 1, No. 8, p. 1.
[17] *Ibid.*, Vol. 1, No. 1, p. 2.

Hsu also noted that the trees of the southwest highland are dwarfed and twisted, being affected by the high altitude, low temperature, and strong winds. During his visit to Heng shan, he further observed that the vegetation of the northern slopes of mountains differs from that of the southern slopes, since the different slopes do not receive the same amount of sunshine and rain.

One can get a vivid impression of the subtropical vegetation in southwestern China from reading Hsu's accounts. On November 27, 1637, while traveling in western Kwangtung, he wrote: "I found dense forest for three *Li* while climbing to the peak. Looking down to the curved valleys [I saw] the trees woven together and the leaves so meshed that even a bird could hardly penetrate them."[18] During the winter such dense forest seldom occurred in high elevations except in areas of low latitude like Kwangtung. Again, on July 13, 1639, at Paoshan, Yunnan, he wrote this description: "The thousands of trees reach to the sky while tendrils and moss tangle together below."[19]

Hsu was indeed a great interpreter of nature.

Hsu's Diary as a Source for Map Compilers and Surveyors

Hsu's diary gives such an accurate and detailed account of the regions he visited that it was used by early Europeans in compiling the first western atlas of China in the seventeenth century and was also used as reference for the surveying work of the country in the eighteenth century.

Atlas Sinensis was the first western atlas of China. It was published in 1655 at Amsterdam and was compiled by Father Martin Martini (1614–61), an Italian Jesuit who came to China two years after Hsu's death. In addition to one hundred and seventy-one pages of text, this atlas contained a general map of China, a general map of Japan, and fifteen maps of different provinces of China. The atlas was translated into many languages and was widely used in Europe.[20] Because of the technical excellence of its production and the fact that it was long the only atlas of China available in Europe, it was the standard geographical work on that country.

In compiling the *Atlas Sinensis*, Martini

[18] *Ibid.*, Vol. 1, No. 7, p. 22.
[19] *Ibid.*, Vol. 2, No. 18, p. 16.
[20] R. V. Tooley, *Maps and Map-makers* (B. T. Batford, Ltd. 1949), p. 106.

used many of the available Chinese sources.[21] A Chinese clergyman, Fang Hao, has stated that Martin Martini's atlas was partly based on Hsu's diary as a source.[22] A French Jesuit, Henri Bernard, has also substantiated that Martin Martini used Hsia-ke Hsu's diary to compile his famous atlas.[23] Hsu's diary was a valuable and reliable source for this famous map compiler in the sixteenth century.

During the years from 1708 to 1719, an extensive geodetic survey and mapping was carried out in China by the western missionaries at the order of Emperor Kang-hsi. At this time geodetic surveys in Europe had just started, yet in China the whole surveying work had been completed.[24] This surveying fixed accurately the exact latitude and longitude location of large cities and laid a foundation for the mapping work in China. In completing this surveying and mapping work in China, Martin Martini's *Atlas Sinensis* was used as an important source.[25] Thus Hsu's diary also contributed indirectly as a source for this surveying work in the early Ching dynasty, since Hsu's diary was a source for compiling *Atlas Sinensis*. Fang even maintained that the western missionaries of the early Ching dynasty had direct contact with Hsia-ke Hsu and had used Hsu's diary as a first-hand source.[26]

Thus the diary of Hsia-ke Hsu served as an essential scientific document in the mapping of China in the early eighteenth century.

Hsu's Introduction of Field Work in Chinese Geography

The study of geography is an old subject in China. The early Chinese conceived the science of geography in terms of maps, political boundaries, mountains, waterways, products, monuments, local customs, etc. Like the Roman Empire in the west, ancient China excelled in regional description known as *Fang Chih* which gives accounts of the historical, economic, social, industrial and other aspects of the political regions, and the recording of mountains, rivers, and temples is illustrated by wood-cuts. Compiled generally by retired scholars native to the area and financed by public or semi-private enterprise, they are invaluable to the store of geographical knowledge in China. As Wylie says, "They are probably unrivalled in any nation for extent and systematic comprehensiveness."[27] *Fang Chih* was essential for every Chinese local library and no local government office was without a set of such local records.

Most of these regional descriptions, however, were only compilations based on second-hand sources. Hsu was not satisfied with these local records, nor was he content to remain at home to do traditional compiling. Instead he contributed to geography in another way. Unlike the gentleman scholars of his day who enjoyed more sedentary pursuits and relied on books alone for geographical knowledge, Hsu chose to devote himself to field work and keeping a day-by-day record of his observations. Field work to a geographer is what laboratory work is to a chemist. Hsu's startlingly modern concept of securing geographical data from the field was an important step in the development of geography in China. Keen observation and detailed recording, the two necessary techniques in field work, were fully recognized and employed by Hsu. He inspired a new method in the science of geography, advocating the need for direct observation and for originality in geographical writing. Hsu was thus the first to undertake geographical exploration. Later geographers, following his example, include Yen-wu Ku (1613–82) and Tsu-yu Ku (1613–92).

Yen-wu Ku, a leading scholar in the early Ching period, also traveled extensively and kept daily notes. His best-known book, *Jih Chih Lu* or *Daily Additions to Knowledge*, was a collection of written notes on a great variety of topics besides geography. In his other important geographic work, *Tien Hsia Chun Kuo Li Ping Shu* or *A Study of Military*

[21] Henri Bernard, S.J., "Les Etapes de la Cartographic Scientifique pour la Chine et les pas voisins, depuis le XVI^{e} Jusqu's la Fin du XVIII^{e} Siècle," *Monumenta Serica*, Vol. 1 (1935–36), p. 447.

[22] Fang Hao, "Hsu Hsia-ke Yu hsi-yang chiao-shih kuan-hsi chih chu-pu yen-chiu" (A Preliminary Study of the Relationship between Hsia-ke Hsu and the Western Missionaries), in *Ti li Hsueh Chia Hsu Hsia-ke* (The Geographer Hsia-ke Hsu), Coching Chu, ed. (Shanghai: Commercial Press, 1948), pp. 11–24.

[23] Henri Bernard, S.J., "Hsien Tai chung Kuo Wen Hua Tsien chu Kuan-chi Hsu" (Kuan-chi Hsu, the forerunner of modern culture in China), in *Sheng chiao Tsai chih* (Shanghai, 1933), Vol. 22, No. 11.

[24] Walter Fuchs, "Materialien zur Kartographic der Manju-Zeit," *Monumenta Serica*, Vol. 1 (1935–56), p. 387.

[25] Fang, *op. cit.*, p. 15.

[26] *Ibid.*, pp. 23–24.

[27] Needham and Wang, *op cit.*, p. 120.

and Economic Geography, he laid stress on places of strategic importance, on taxation, and on waterways. Both books were the result of careful observations he made in the course of his long journeys on horseback. The well-known geographic work of Tsu-yu Ku was *Tu Shih Fang Yu Chi Yao* or *Essentials of Historical Geography* which identified more accurately than any preceding geographic work the changes of political boundaries and the place names in various periods of Chinese history. In writing this book, Ku utilized not only the rich library sources, but also relied heavily on travel and inquiry.

Hsu's inspiration in field work was not only recognized by his immediate individual followers, but also by scientific organizations at a much later date. The National Geological Survey, founded in 1916, is one of the most important scientific organizations in modern China. Under the leadership of Dr. V. K. Ting (1887–1936), the first director of the survey, field work was carried out in all parts of China and much valuable geographical information was accumulated. Ting was a great admirer of Hsia-ke Hsu for his pioneer field work. When Ting made a geological survey in the Yunnan–Kweichow plateau in 1911 and 1914, he declared that Hsu was his patron saint.

In short, Hsu's observation of the landscape was keen, his description of nature was vivid, his explanations of geographical phenomena were reasonable, and his field work was startlingly modern in spirit. His great skill in field observation and descriptive writing made him the true forerunner of modern geography in China.

ALTERNATE EXPLANATIONS OF URBAN RANK–SIZE RELATIONSHIPS[1]

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PICK any large area. It will likely contain many small cities, a lesser number of medium-size cities, and but few large cities. This pattern of city sizes has been observed to be quite regular from one area to another. That is, when the frequency of occurrence of city sizes in any area is compared with the frequency of occurrence of sizes in another area, the two frequencies are very much alike. An example is furnished by a comparison of city sizes and ranks in the Republic of Korea and the state of Washington (Figure 1). Frequencies for the two areas are quite similar. Such empirical regularities of city size have been noted many times and have long posed a challenge to those who would explain or interpret them.[2]

Several explanatory schemes directly or indirectly related to the problem of repeated regularities of patterns of occurrence of city sizes have been proposed. The present discussion brings these schemes together for comparison, namely, the schemes or theories of G. K. Zipf, W. Christaller, N. Rashevsky, and H. A. Simon.[3] In the ensuing discussion it will be noted that city size regularities associated with Zipf have been explained by Simon using very simple probability notions. Too, it will be noted that the city size rule of Zipf is consistent in special cases with the theories of Rashevsky and Christaller. Since Rashevsky's scheme is a contribution to the general theory of urbanization and economic opportunity, and since Christaller's theory is the generic base of theories of urban size, function, and arrangement (subsequently generalized in several respects by August Lösch[4]), city size relations are consistent with more general theory. The alternatives and issues involved in the researchers' choice between the simple

[1] This article is entirely expository. It elaborates diverse ideas that the authors have found difficult to resolve and it is hoped that it will stimulate more detailed explanations. For such explanations we are already indebted to Messrs. Vir Bhatia, Harvard University, Richard Quandt, Princeton University, and Duane Marble, University of Washington.

[2] Edgar M. Hoover has pointed out the need for an adequate explanation in "The Concept of a System of Cities: A Comment on Rutledge Vining's Paper," *Economic Development and Cultural Change*, Vol. 3 (1955), pp. 196–98.

[3] George K. Zipf, *Human Behavior and the Principle of Least Effort* (Cambridge: Addison–Wesley Press, Inc., 1949); W. Christaller, *Die zentralen Orte in Süddeutschland* (Jena: Gustav Fischer, 1933, translated in 1954 at the Bureau of Population and Urban Research, University of Virginia, by C. Baskin); N. Rashevsky, *Mathematical Theory of Human Relations*, Mathematical Biophysics Monograph Series, No. 2 (Bloomington: The Principia Press, Inc., 1947); Herbert A. Simon, "On a Class of Skew Distribution Functions," *Biometrika*, Vol. 42 (1955), pp. 425–40, reprinted as Chapter 9 of *Models of Man* (New York: Wiley, 1957). Note that when practicable in our ensuing discussion of these studies the terminology of original authors is maintained.

[4] August Lösch, *Die räumliche Ordnung der Wirtschaft* (Jena: Gustav Fischer, 1939), translated by W. H. Woglom and W. F. Stolper as *The Economics of Location* (New Haven: Yale University Press, 1954).

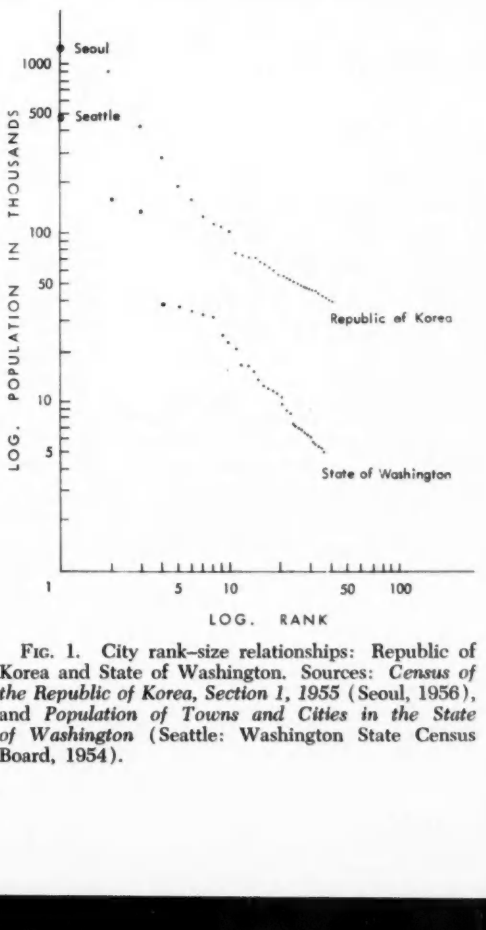

FIG. 1. City rank–size relationships: Republic of Korea and State of Washington. Sources: *Census of the Republic of Korea, Section 1, 1955* (Seoul, 1956), and *Population of Towns and Cities in the State of Washington* (Seattle: Washington State Census Board, 1954).

explanation offered by Simon and the less simple alternates of others pose the concluding problem of the discussion.

CITY SIZES

The problem before us is posed by a comparison of city populations and ranks. In any area, say a nation, cities may be ranked from the largest to the smallest according to population. The largest city would rank number 1, the second largest number 2, etc. When these ranks are then plotted against city population size a regular relationship emerges. There are few large cities and many small ones and there is an apparent empirical relationship between the rank of a city and its population. The size relationship takes the form $r_i\ (p_i{}^q) = K$, when q and K are constants, r_i is the rank of the ith city and p_i is the population of that city. Observed distributions are concave upward and are linear or nearly so when plotted using logarithmic axes.

These city size relations, termed the rank–size rule, have been noted by a number of persons.[5] Valuable empirical studies are due to Zipf who has compiled and published data for several countries.[6] As W. Isard has pointed out, however, a number of persons had noted the empirical relationships earlier.[7] The empirical evidence is formidable and has recently been reviewed by Vining[8] and Isard,[9] and augmented by G. R. Allen[10] and C. H. Madden.[11] For these reasons it will not be reviewed here.

Any empirical regularity poses problems for theory. Observations of city rank–size relationships have served both to initiate and to verify theory, the two classic functions of empirical work. Zipf has attempted to erect a scheme to explain rank regularities and Rashevsky has turned to Zipf's observations for partial verification of his theoretical scheme. Like Zipf, Simon has attempted a theoretical scheme to explain empirical regularities, and as with Rashevsky, observations of rank–size relationships are consistent with the scheme of Christaller. Empirical regularities, then, are a common element in a variety of undertakings and they serve as a link among divergent approaches to a common problem.

In connection with rank–size relationships the question has been asked, Is there in fact a regularity?[12] A scatter of dots formed by plotting the sizes of cities versus their rank never presents a perfect alignment of dots along a mean line. One dot will fall above the line, another below, and so on. Some misfit is expected, of course, due to different definitions of the area of the city and other data liabilities.[13] The problem is whether regularity occurs, leaving these sources of error in the data aside.

It is sufficient for the present problem that regularities may exist. One point about the problem of empirical validation should be made, though. There is never perfect agreement of data with theory. Thus a number of statistical tools have been developed to test hypotheses of agreement. Paralleling these

[5] Well-known references to city size relationships in the geographical literature are those of Mark Jefferson, e.g., "The Law of the Primate City," *Geographical Review*, Vol. 29 (1939), pp. 226–32, and J. Q. Stewart, "Empirical Mathematical Rules Concerning the Distribution and Equilibrium of Population," *Geographical Review*, Vol. 37 (1947), pp. 461–85, especially pp. 462–67. A recent reference to expected city size relationships is in P. E. James and Speridiav Faissol, "The Problem of Brazil's Capital City," *Geographical Review*, Vol. 46 (1956), pp. 301–17. One of the very early studies was that by Felix Auerbach, "Das Gesetz der Bevolkungskonzentration," *Petermann's Geographische Mitteilungen*, Vol. 59 (1913).

[6] *Op. cit.*, and *National Unity and Disunity* (Bloomington: The Principia Press, 1941).

[7] Walter Isard, *Location and Space Economy* (New York: John Wiley and Sons, Inc., 1956), pp. 55–60.

[8] "A Description of Certain Spatial Aspects of an Economic System," *Economic Development and Cultural Change*, Vol. 3 (1955), pp. 147–95.

[9] *Op. cit.*

[10] "The 'Courbe des Populations', A Further Analysis," *Bulletin of the Oxford University Institute of Statistics*, Vol. 16 (1954), pp. 179–89. Allen fitted the Pareto formula to 44 countries and finds: "The main conclusion is, therefore, that the Pareto Law can be used with much success to summarize the relationships between size of towns and number of towns above a specified size" (p. 184). The Pareto formula is similar to what Zipf has termed the rank–size rule. Explanations of it are to be found in R. G. D. Allen, *Mathematical Analysis for Economists* (London: MacMillan, 1950), pp. 407–08, and D. G. Champernowne, "A Model of Income Distribution," *Economic Journal*, Vol. 63 (1953), pp. 318 *et seq.* The earlier empirical application of Pareto's law to city sizes was by H. W. Singer, "The 'Courbe des Populations': A Parallel to Pareto's Law," *Economic Journal*, Vol. 46 (1936), pp. 254–63.

[11] "The Growth of Cities in the United States: An Aspect of the Development of an Economic System" (unpublished Ph.D. thesis, University of Virginia, 1954).

[12] Isard, *op. cit.*, p. 57.

[13] These problems are noted by G. R. Allen, *op. cit.*, and Allen also provides a measure of error or lack of fit.

tests but apart from the statistical problems are problems of interpreting degrees of agreement. Plausibility plays a part here. To the extent that regularity is plausible it is easy to see regularity. If no plausible basis for regularity is known, regularity is difficult to see.

The present discussion reviews plausible bases for empirical regularities between city sizes and ranks, and to the extent that plausibility is provided, the present discussion serves to verify asserted regularities.

ZIPF AND THE RANK–SIZE RULE

Perhaps the best-known elaboration of rank-size regularities was developed by G. K. Zipf.[14] Zipf's discussion was set within a broad context—a general theory of human behavior—in which rank–frequency relationships are noted for many expressions of human behavior (e.g., number of times words were used in a novel). The general theory was presented to explain these regularities.

The discussion as a whole has been reviewed elsewhere.[15] Too, the portion of the discussion treating the sizes of cities may be extracted from the larger work without distorting Zipf's analysis. Thus, the general works will not be reviewed at the present time. Zipf presented evidence of strong rank–size relationships. As a case in point, a study of the 100 largest metropolitan districts in the United States in 1940 yielded the best-fitting equation $r=(P^{-1})\ 10{,}000{,}000$. [16] This equation, Zipf noted, indicated that $K = 10{,}000{,}000$ and was approximately equal to the population of the largest metropolitan district. Since the exponent q equals 1, it indicated the equality of the forces of diversification and unification.[17] The latter requires elaboration.

Diversification versus unification. Zipf's explanation of rank–size relationships is in broad outline quite simple. On the one hand, it is postulated that there is a tendency for the population to be split into many small autarchic communities. This process, labeled the force of diversification, is that of economical location relative to raw materials. Persons are located to minimize the transfer cost of obtaining raw materials. A society using many scattered raw materials would be highly dis-

[14] *Human Behavior . . . , op. cit.*

[15] See, for example, the review by Read Bain in *Social Forces*, Vol. 28 (1950), pp. 340–41.

[16] Zipf, *Human Behavior . . . , op. cit.*, p. 375.

[17] *Ibid.*, p. 376.

aggregated in location; a society using few strongly localized raw materials would be highly aggregated in location.

On the other hand, there is a reverse tendency, the force of unification. Diversification tends to minimize the difficulty of moving raw materials to the places where they are to be processed; unification tends to minimize the difficulty of moving processed materials to the ultimate consuming populace. If all persons in the society were located at the same point, then maximum unification would be achieved. When both the forces of diversification and unification are at work a distribution of population is presumed to occur that is at optimum with reference to both forces.

The domains of goods. An additional concept of Zipf's theory is the notion of the domain in which goods may be economically traded. Zipf notes that different goods have different cost relationships. Some are marketed in many small domains, others in large domains, and so on. Each good is made from a unique mix of raw materials, but groups of goods may be produced in the same community.

Formulation of the rank–size rule. Thus far the Zipf scheme is simple and straightforward. However, the manner by which one moves from these simple notions to the rank–size rule is less clear, namely,

> Since the Force of Diversification makes for a larger n number of small P communities, whereas the Force of Unification makes for a smaller n number of larger P communities, then, if we interpret the relationship as a best straight line on doubly logarithmic co-ordinates, the result will be that the n number of different communities, when ranked r, in the order of their decreasing P size will follow the equation (approximately):
>
> $$r = P^{-q}K \ . \ . \ .$$ [18]

Contributions of Zipf. It is certainly not clear just what are the logical links between the scheme proposed by Zipf to explain rank–size regularity and observed rank–size regularities. Thus, it would not be proper to credit Zipf with an articulated empirical and theoretical analysis of the rank–size problem. On the other hand, in several important ways Zipf deserves great credit.

Zipf's works have called emphatic attention to the rank–size problem. The number of students who have been attracted to the problem as stated by Zipf is, of course, unknown. But two of the contributions to the rank–size prob-

[18] *Ibid.*, p. 359.

lem (both to be reviewed), those of Rashevsky and Simon, give direct credit to Zipf for calling attention to the problem. Both of these give credit to the empirical substantiation of rank–size regularities, rather than to Zipf's theoretical formulation of the problem.

Too, Zipf has proposed, or at least restated, components of the emerging general theory of location. His discussion of unification and diversification is related to Weberian localization schemes and the notion of the range of a good is similar to that of Christaller.[19] In this latter sense, Zipf's statements are not original, but they do have the virtue of consistency with other literature.

CHRISTALLER AND SIZE CLASSES OF CITIES

A well-known alternate scheme to that of Zipf, both regarding the size of cities and the processes causing size regularities, is that of W. Christaller.[20] It is quite surprising that the scheme of Christaller has never (to the writers' knowledge) been compared with the scheme or the empirical observations of Zipf in terms of city sizes. The two schemes are quite similar. Both utilize notions of the domains of cities (domains of goods) for the performance of various economic activities.[21] Too, the rules of behavior leading to the spatial system of central places and associated arrangements of city sizes (diversification and unification) are quite similar.[22] In both schemes as the population of cities increases, the number of centers of this population diminishes.

It should be recalled that Christaller's work was somewhat broader than that of Zipf; Christaller was concerned with the spatial arrangement, function, and size of urban centers. Too, it should be recalled that Christaller did not provide a general theory in formal terms.[23] So far as general theory is concerned, there is no explicit way the scheme of Christaller may be compared with that of Zipf despite the fact that the notions of the two schemes are, as already noted, quite similar.

Special cases. Turning to special cases, however, it is practicable directly to compare the scheme of Christaller with that of Zipf. Christaller did provide a formal statement of one network of cities in homogeneous space. This is the well-known $k = 3$ network, with one "primate city" of population K, and $r = 1$; three cities of population $K/3$, and $r = 2$; nine cities of population $K/9$ and $r = 3$; twenty-seven of population $K/27$; etc.[24] This arrangement of city sizes may be compared directly with the rank–size rule provided by Zipf.

In order to make the comparison the steps of the hierarchy of centers in the $k = 3$ scheme are taken as ranks, $r = 1, 2, 3$, etc., and $P_i = K, K/3, K/9$, etc. A rank–size distribution in the manner of Zipf is formed if the exponent

$$q = \frac{\log\ (K/r)}{\log\ (K/3^{r-1})}.$$

Thus, where $r = 2$

$$q = \frac{\log\ (K/2)}{\log\ (K/3^{2-1})}$$

and if $q \cdot \log P = \log\ (K/r)$

$$\text{then} \qquad \log\ P = \log\ (K/2) \cdot \frac{\log\ (K/3)}{\log\ (K/2)}$$

and $P = K/3$ as required by Christaller's theory.

Implications. In fact no great difference exists between Zipf and Christaller; on the level of the intuitive statement of basic notions the two schemes seem very much alike. Even when one turns to special cases generated by the schemes certain relationships are evident.[25] By the proper choice of relationships, the class hierarchical scheme of Christaller may take on the rank–size character of Zipf's

[19] Zipf was cognizant of these works and used them as references.

[20] Christaller, *op. cit.*, especially pp. 63–4.

[21] *Ibid.*, pp. 20, 31, 54. Both Hoover and Vining link the schemes of Zipf and Christaller through the notion of domain.

[22] *Ibid.*, pp. 63–74.

[23] Christaller addressed the general problem of city size and arrangement on an informal and intuitive level. His discussion is formal only with his example case of the $k = 3$ network. It is not clear why Christaller has been criticized for lack of generality. See the comments upon this common criticism in Brian J. L. Berry, "Geographic Aspects of the Size and Arrangement of Urban Centers" (unpublished Master's Thesis, University of Washington, 1956), pp. 7–30. Our attention has been called to C. W. Baskin's, "A Critique and Translation of Walter Christaller's *Die zentralen Orte in Süddeutschland*" (unpublished Ph. D. dissertation, Department of Economics, University of Virginia, 1957), but we have not had the opportunity of examining this study.

[24] A discussion of this network as well as other networks is available in August Lösch, *op. cit.*, p. 131.

[25] It is to be noted, of course, that our Christaller formulation refers to a rank–size regularity of hierarchical classes of city sizes.

observations. The Christaller scheme is consistent with Zipf's empirical observations, but consistency requires a rigorous choice of relationships.

RASHEVSKY, URBANIZATION AND ECONOMIC OPPORTUNITY

As was true of both Christaller and Zipf, N. Rashevsky's deductions bearing on city size were set within a larger context.[26] Rashevsky set out a general theory of human relations in mathematical form. In this general theory the spatial distribution of individuals and the size of cities were core topics.[27] Observed empirical regularities in the distribution of city sizes were approached in a different manner from the two topics just mentioned.[28]

Rural versus urban opportunities. Rashevsky's approach to the urbanization problem was via an evaluation of alternate economic opportunities.[29] The rural–urban division of population was seen directly related to the level of opportunities in each area. There are N_r rural persons and N_u urban ($N_r + N_u = N$) and p_r and p_u indicate the corresponding production per person. In general,

$$p_u = f_u(N_u, N_r); \quad p_r = f_r(N_u, N_r)$$

and the condition $p_u = p_r$ is assumed. This is an extremely interesting system that leads to some interesting results bearing on relations between urbanization and population changes.[30]

While the simple system just mentioned offers a first approximation to the urbanization problem it throws no light on the city size problem, which is approached by enlarging the scheme to identify the number and sizes of cities. If the productivity, p_i, per person in cities of population size n_i is

$$p_i = f(n_i, N_i)$$

(where N_i is the total number of persons in all cities of size n_i) and $p_1 = p_2 = , \ldots , = p_n$ (where $i = 1, 2, \ldots , n$), then: $p = f(n_i, N_i)$ and all city sizes are presumed determined.

Now, like many schemes, once presented, these notions of Rashevsky's seem utterly elementary and obvious and this is to Rashevsky's credit. An equilibrium in city size is presumed to be reached when the production per person in each city is the same. There is no allowance for lag and it is not completely explicit how equilibrium processes work. But the system seems a reasonable first approximation of reality. Is it consistent with observed rank–size regularities of the present problem? The answer to this is a qualified No; this production opportunity view of equilibrium is not one which generates rank–size regularities directly.[31]

Types of activities. On the other hand, the evidence offered by Zipf's rank–size observations was so strong that Rashevsky attempted to reformulate his city size system in a manner that would tailor directly to rank–size observations. To do this the distribution function of the gradation of numbers of persons performing different types of activities in urban centers was considered. (For example, one could consider the distribution in urban centers of groups of persons associated with government activities). After considerable manipulation of this idea, it was shown that city size as a function of the distribution of activities can in a special case approximate the observed rank–size distributions.

Implications. As was the case with Christaller's scheme, observed rank–size regularities would seem neither to contradict nor to support the scheme of Rashevsky, which will produce rank–size relationships as a special case. As with Christaller, the scheme of Rashevsky's is consistent with Zipf's empirical observations, but consistency requires a set choice of relationships.

SIMON AND A PROBABILITY EXPLANATION

Like Rashevsky, H. A. Simon attempted an explanation of observed rank–size regularities.[32] Simon's explanation formed an integral part of an approach to a general systems theory based on broad analogies between the

[26] N. Rashevsky, *op. cit.*

[27] *Ibid.*, chaps. 10 and 11.

[28] *Ibid.*, chap. 12.

[29] Rashevsky's discussion is entirely in economic terms, i.e., he speaks of the opportunities for the production of economic goods. As he points out (*ibid.*, p. ix), however, the discussion could have been cast around satisfaction functions. This practicability removes the argument that Rashevsky's discussion is overly restricted.

[30] *Ibid.*, pp. 85–87, and Rashevsky, "Contribution to the Theory of Human Relations: Outline of a Mathematical Theory of the Size of Cities, VII," *Psychometrica*, Vol. 8 (1943), pp. 87–90.

[31] This conclusion is reached by Rashevsky, *ibid.*, pp. 94–5. For some interesting empirical observations relating to population distribution and city sizes see A. H. Hawley, *The Changing Shape of Metropolitan America* (Glencoe, Illinois: The Free Press, 1956), pp. 34 *et seq.*

[32] *Op. cit.*

frequency distribution of a wide variety of biological, social, and economic phenomena observed by Zipf and others.[33] Such phenomena include distributions of words in prose samples by frequency of occurrence, distributions of numbers of scientists by numbers of papers published, distributions of incomes by size (Pareto distributions), and distributions of biological genera by numbers of species, in addition to the distributions of city sizes. Simon was unwilling to suppose initially that there was any connection between these phenomena other than that known probability mechanisms might provide satisfactory abstract models of each, and provide the bases of analogies.

The distributions. Simon argued that the distribution of city sizes was one of a family of distributions which have the following general characteristics in common:

(a) They are *J*-shaped, or at least highly skewed, with very long upper tails which can be approximated closely by a function of the form

$$f(i) = (a/i^k)b^i$$

where a, b and k are constants, and the convergence factor b is so close to 1 that it often may be disregarded. Thus, for example, the number of cities that have a population i is approximately a/i^k.

(b) The exponent k is of the form $1<k<2$.

(c) The function describes the distribution not merely in the tail, but also for small values of i. In this case it may be shown for example, that $f(2)/f(1) = 1/3$ and $f(2)/f(n) = 1/2$,

where $n = \sum_{i=1}^{\infty} f(i)$.

These three properties just identified define the class of functions which Simon terms the Yule distribution. The term is used because G. Udny Yule used the distribution some years ago to explain the distribution of biological genera.[34] Simon reconstructed Yule's probability model using only a weak set of assumptions and modern theory,[35] and made the initial steps in applying it to city sizes.

Underlying mechanism. Stated in terms of the city size problem, the distribution derived by Simon is evolved under roughly the following notions. Consider a total population k distributed in cities, with a city considered to be an aggregate of population larger than some threshold size. The probability that the $(k+1)$st person being found in cities of size i is assumed to be proportional to $i[f(i,k)]$. It is also assumed that there is a constant probability α that the $(k+1)$st person will be in cities not previously of threshold size when the total population was k.[36]

It must be emphasized that these are extremely weak assumptions. They would hold roughly, for example, if population change were simply proportional to present population.

The Model. It is not practicable to reproduce Simon's derivation of the probability model here.[37] The derived set of equations from which expected distributions of cities may be calculated is as follows:

$$(a) \quad \alpha = n_k/k$$

$$(b) \quad f(1) = n_k/2 - \alpha$$

$$(c) \quad f(i)/f(i-1) = (1-\alpha)\cdot(i-1)/1 + (1-\alpha)i$$

where k is the total urban population in the n_k cities of greater than threshold size, and $f(i)$ is the number of cities of population i. From equation (a) and equation (b), and by successive application of equation (c) the expected distribution of city sizes can be con-

[33] For a development of this notion of a general systems theory see H. A. Simon and A. Newell, "Models: Their Uses and Limitations," in L. D. White, ed., *The State of the Social Sciences* (The University of Chicago Press, 1956), pp. 78–9.

[34] "A Mathematical Theory of Evolution Based on the Conclusions of Dr. J. C. Willis, F. R. S.," *Philosophical Transactions*, Vol. 213 (1924), pp. 21–84. Vining, *op. cit*, recognized the contribution of Yule.

[35] But in several alternate formulations Simon was able to show that a variety of different assumptions did not materially alter the shape of the derived distribution. This he took to indicate the value of the probabilistic explanation.

[36] Whereas the second assumption is very weak, Simon states that the first assumption will be satisfied if the growth rates of cities are stable, not for each city, but for aggregates of cities in each population band. There seems ample evidence of this stability in th pattern of urban growth. See, for example, C. H. Madden, "On Some Indications of Stability in the Growth of Cities in the United States," *Economic Development and Cultural Change*, Vol. 4 (1956), pp. 236–53.

[37] Simon, "On a Class of . . . ," *op. cit.* The use of the derived equations does not follow the precise form prescribed by Simon for city sizes, in which $f(i)$ is the number of cities equal to or greater than size i, but the form outlined in Brian J. L. Berry and William L. Garrison, "A Probability Model of the Distribution of City Sizes" (mimeographed manuscript, Department of Geography, University of Washington, 1957).

structed. Since the situation will scarcely, if ever, be found in which $\alpha > \varepsilon$ (where ε is an extremely small number), we may write this system in the more simplified form:

(b^*) $f(1) = n_k/2$

(c^*) $f(i)/f(i-1) = (i-1)/(1+i)$

From (b^*) and by successive application of (c^*) the expected distribution of city sizes may then be constructed.

An example. The accuracy with which the stochastic model developed by Simon represents the distribution of city sizes may be illustrated by data from the state of Washington. Five thousand urban residents were taken to constitute the threshold at which a nucleated settlement became a city (this figure is entirely arbitrary). Hence $f(1)$ was interpreted as the number of cities with populations of 5,000–10,000; $f(2)$ the number of cities with between 10,000 and 15,000 population; $f(3)$, 15,000–20,000, etc.

The number of cities with populations of 5,000 or greater, n_k, was 36. Hence, as expected in equation (a), α was extremely small, for k was, relatively speaking, very large. From the simplified form of the model, therefore:

$$f(1) = 36/2 = 18 \qquad (b^*)$$

$$f(i)/f(i-1) = f(2)/f(1) \qquad i = 2$$

$$f(2)/18 = (2-1)/(1+2) \qquad (c^*)$$

$$f(2) = 18 \cdot 1/3 = 6$$

By successive application of equation (c^*) where $i = 3$, $i = 4$, etc., the *a priori* distribution of cities in the various size classes has been calculated for the state in Table 1. Note the close resemblance of actual and *a priori* distributions.

The distribution of $f(i)$, the number of cities of size i, may be readily converted into the rank–size distribution, where r_i is the number of cities of size equal to or greater than size i, by the use of the following transformation

$$r_i = n_k - f(i_j)$$

where r_i is the number of centers of population equal to or greater than i, n_k is as before, and $f(i_j)$ is the total number of centers of population less than i. Again, the close resemblance between expected and observed frequencies of city sizes by ranks may be seen in Table 1.

TABLE 1.—CITY SIZES IN THE STATE OF WASHINGTON

Population of cities in 1,000's	Number of cities of this population $f(i)$		Number of cities equal to or greater than this population (r_i)	
	Expected	Observed	Expected	Observed
5–10	18	16	36	36
10–15	6	6	18	20
15–20	3	3	12	14
20–25	2	2	9	11
25–30	1	1	7	9
30–35	1	2	6	8
35+	5	6	5	6

STATUS OF THE PROBLEM

There seems to be no doubt that the empirical regularity with which we are concerned exists. The weight of empirical evidence for regularities has been given substance by Simon's derivation of accurate expected distributions utilizing stochastic processes and probability concepts. Plausibility does not require real understanding of causal processes, however, and it is not immediately clear where one should look for causal explanations.

The simplest alternate. Walter Isard has noted that "Zipf . . . has intuitively associated city size with the market area complex . . . although the logic connecting his statistical findings on the one hand and his Forces of Unification and Diversification and the principle of least effort on the other hand is not at all clear."[38] The notions of Christaller and Rashevsky are tenuously linked to the problem of rank–size, relating only in special cases. These theories may be suggested to explain city size regularities, but they seem both divergent and generally inadequate.

If we were to use the dictum of the simplest of alternate hypotheses, the selection of explanations would be clear. Instead of the troublesome theories of Zipf, Rashevsky, and Christaller, one would rely for explanation of city–size regularities on the implications of the work of Simon. Simon's scheme is simple and it works (in Washington state, for example, the expected frequency was very much like the observed distribution of city sizes). The alternatives are to derive explanations of the observed distributions of city sizes from underlying distributions of occupations (Rashevsky), or of agglomeration and dispersion tendencies (Zipf and Christaller). These require very specific and not very plausible assumptions about the distribution of occupa-

[38] Isard *op. cit.*, p. 60.

tions and dispersion and agglomeration tendencies, and such assumptions simply serve to transfer the mystery from the frequency distribution of city sizes to other frequency distributions.[39]

But on the other hand, the city size problem seems to be a case where the available simple explanation is unsatisfactory. For one thing, a probabilistic explanation in some sense refers to the presence of an infinite number of causes and the ability to predict in these terms is not enough; we wish explanations viable in explicit ways within a broad theoretical context. As John Somerville has pointed out, ". . . , no problem is worth working on that does not involve a deliberately formulated hypothesis which has scientific implications beyond the original problem."[40] Some would argue that the probabilistic explanation is meaningful in a theoretical context and has scientific implications, as noted in the discussion of average conditions in paragraphs below. The theory still leaves a central question unanswered, namely: Why is the arrangement of city sizes the outcome of simple probabilistic processes?

What is needed. What are the implications from noting our present level of knowledge regarding city sizes? One answer to this question seems clear. Present knowledge of processes of urbanization is skimpy. From the standpoint of numbers of available studies, there has been little concern with a general theory of city size, function, and arrangement. What is more amazing, this is true in spite of our great concern with studies of urban areas. It is obvious that here is a place where there is great need for *articulated* empirical and theoretical research. We also need a point of view; it has to be decided what is important to explain.

Average conditions. To elaborate the point of the preceding sentence, one may note that work may be done without explicitly stating the causes of rank–size distributions of city sizes. Madden has noted that the rank–size formulation exhibits stability over time.[41] Others have noted stability from nation to nation, and Simon gives us a simple explanation for this stability. This, then, is an average condition, both from empirical and theoretical points of view. We have already mentioned the notion of a general systems theory.[42] One point emphasized in this theory is that living systems tend to maintain steady states of many variables which keep all subsystems in order of balance both with one another and with their environments. These steady states are described in terms of entropy, in accordance with the second law of thermodynamics, in which entropy is a state of randomly distributed energy, and essentially a "normal or average state" of equilibrium. That the rank-size distribution is a random state is borne out by Simon. As such it is a condition of entropy or equilibrium and is a proper subject of systems theory. Thus city size problems may be treated as average conditions, *and* in the more general context of the development of systems theory.

Variations. On the other hand, one may argue that it is variations from and between average conditions which pose the problems for theory.[43] A region containing cities all approximately the same size would pose many interesting questions. A region with a rank-size arrangement of cities merely represents the occurrence of average conditions. Too, many interesting problems would result from comparisons of city-size frequencies in different regions.[44] Absence of significant dif-

[39] These sentences follow remarks made by Simon in a similar context: "Productivity among American Psychologists. An Explanation," *American Psychologist*, Vol. 9 (1954), p. 805.

[40] John Somerville, "Umbrellaology, or Methodology in Social Science," *Philosophy of Science*, Vol. 8 (1941), p. 564.

[41] Madden, *op. cit.*

[42] A lucid development of this idea has been provided by J. G. Miller, "Toward a General Theory for the Behavioral Sciences," *American Psychologist*, Vol. 10 (1955), pp. 513–32.

[43] James and Faissol, *op. cit.*, provide an example of this point of view. It should also be remembered that Mark Jefferson thought in terms of a "law" of the primate city. *Op. cit.*

[44] It would be interesting to treat the rank–size distribution as a lognormal distribution, for as Aitchison and Brown have noted, ". . . many of these distributions [of Zipf] may be regarded as lognormal, or truncated lognormal, with more prosaic foundations in normal probability theory." J. Aitchison and J. A. C. Brown, *The Lognormal Distribution* (Cambridge, 1957), p. 102. It would then be possible to test for significant differences from lognormalcy for any one distribution, and for significant differences between lognormal distributions, using the tests outlined by Aitchison and Brown. Krumbein is one of the several geologists who have used lognormal distributions to characterize distributions. W. C. Krumbein, "Application of Statistical Methods to Sedimentary Rocks," *Journal of the American Statistical Association*, Vol. 49 (1954), p. 51.

ferences between frequencies would indicate that similar processes of urbanization were operating in both regions; presence of significant differences would indicate the operation of differential forces of urbanization.

Average conditions can also contain within them important problems. Madden maintains that if the empirical distributions are plotted for a series of years, then it is possible to trace the fortunes of cities or groups of cities within these average conditions and relative both to other cities and to the general tendency for growth in the economy. These variable fortunes may then be taken and explained as the first step in the explanation of the general processes of economic growth in the economy.[45]

What is apparent from the foregoing is that a variety of points of view of the problem are permissive, but that search for important causes can also take one *away* from factors generating average conditions (the normal state, or entropy), even though, as Madden has pointed out, one may still perform valuable work within the context of average conditions. It is clear that, in any case, the available explanation for city size relationships is a base on which to build or to relate city size relationships to other relationships. It is certainly not the answer to all city size problems.

[45] Madden, *op. cit.*, and "Some Spatial Aspects of Urban Growth in the United States," *Economic Development and Cultural Change*, Vol. 4 (1956), pp. 371–87; J. R. P. Friedmann, "Locational Aspects of Economic Development," *Land Economics*, Vol. 32 (1956), pp. 213–27.

MAP SUPPLEMENT TO THE ANNALS

A "Map Supplement" to the *Annals* was approved by the Council at the national meeting of the Association of American Geographers in Cincinnati on April 7, 1957. The objective is to provide a publication outlet in the Association for the cartographic portrayal of geographic data on a format larger than *Annals* page size. The Council is convinced that maps dealing with particular areas or subjects can be made to stand alone, requiring little or no explanatory text.

To implement the publication of such maps, the Council approved the appointment of Dr. Erwin Raisz as Map Editor for the Supplement. He is to encourage the preparation of maps in appropriate format and with adequate research significance for publication. The Map Editor is authorized to accept or reject maps submitted for publication in the Supplement and will attempt to obtain funds to cover the costs of publication for maps he accepts. Because color reproduction is very costly, emphasis should be placed on black-and-white maps. If an unusually fine map, dealing with a highly significant topic, is submitted for reproduction in color, it will be given consideration. It is suggested, however, that authors of such maps correspond with the Map Editor during the early stages of planning and compilation.

The general specifications for maps intended for publication in the Supplement are similar to those for sheets of the *National Atlas of the United States*. These specifications will be published in a forthcoming issue of the *Professional Geographer*, with suggestions on the mechanics of preparing the maps.

The Council indicated that only the highest quality maps should be given consideration. It is hoped that several such maps will be submitted within the next year to initiate and demonstrate the value of this new channel for the dissemination of geographic knowledge in cartographic form. Members of the Association who have compiled maps representing significant research, and who will draft them according to specifications, are encouraged to submit the manuscript drawings to Dr. Erwin Raisz, 107 Washington Avenue, Cambridge 40, Massachusetts.

EXECUTIVE COMMITTEE
ASSOCIATION OF AMERICAN GEOGRAPHERS

REVIEW ARTICLES

RECENT METHODOLOGICAL CONTRIBUTIONS TO GERMAN ECONOMIC GEOGRAPHY

Approximately ten years ago Carl Troll summarized the development of scholarly German Geography, described its continuance during the Second World War, and outlined its then current status.[1] One of the basic theses of his overview was that German Geography had emerged from a late-nineteenth-century period of prevailing attention to natural features and the deterministic influence of such features upon human beings and their creations, and had come to occupy a position among the natural sciences, the social sciences, and the arts. With the advent of Cultural Geography (Anthropogeography), the simple nature–human causal relationships that previously had preoccupied many geographers were recognized as invalid and were replaced by the concept of a detailed network of natural and cultural interassociations. Furthermore, the introduction of Cultural Geography resulted in an emphasis upon function (instead of pure causality) and historical development (instead of purely statistical considerations).

Perhaps even more important, the new trend altered the procedures to be followed in regional investigation (*Landschaftskunde*) to the extent that regions no longer were to be appraised on the basis of natural features alone or of causal relationships between selected natural and human features, but were examined in order to understand entire complexes of intricately interwoven qualities ranging from manifestations of landforms and climate to landscape expressions of the "personality or spirit of economic endeavors" (the *Wirtschaftsgeist* of Alfred Ruehl) and of religions. Thus both Natural and Cultural Geography became very decidedly a part of a methodology applicable not so much to inert phenomena as to changing features and milieus bound together by dynamic ties, the most active of which are the work processes of livelihood. In regional inquiry, which Troll maintained is at the center of geographic investigation, Geography had developed a threefold responsibility: (1) the recognition and delimitation of regions, of which some may be patterned horizontally (in non-mountainous areas) or vertically (in mountains); (2) the functional analysis of the relevant contents of each region and of the manifold interassociations among those contents; and (3) by comparing the various regions, the selection of types which can be studied individually or classified from different cultural and natural viewpoints.

Although Troll was viewing the entire field of Geography, his words are not without significance to economic geographers. By pointing to the importance of livelihood in regional interpretation, and by placing regional interpretation at the very heart of the total discipline, he suggested a vital position and responsibility for Economic Geography—a remarkable implication when the stage of development of Economic Geography in Germany at the time he was writing is considered. Embodied initially within general geographic studies (when regarded at all), Economic Geography did not begin to receive appreciable notice as a subdiscipline until the approximate turn of the century when, as Troll has stated, it emerged as a dynamic component of Cultural Geography. Given stimulus at that time by a number of geographers, many of whom were influenced by colleagues in Economics and other related disciplines, it had only begun to receive serious attention a decade ago. Furthermore, two of its most devoted and active twentieth-century leaders, Alfred Ruehl and Leo Waibel, had essentially passed from the scene by the time Troll wrote his appraisal (Ruehl died in 1935, Waibel in 1951), although their influence, of course, remains.

In the ten years following Troll's statement, German Economic Geography has acquired a firmer foundation. It has taken stock of itself and appears to be on the verge of more than noteworthy achievement. The self-appraisal has resulted in the publication of several books and articles, the most outstanding of which are the five volumes of the *Erde und Weltwirtschaft* series, edited by Rudolf Luetgens, written by him in cooperation with Erich Otremba and Edwin Fels, and completed in 1957.[2] This series constitutes the most comprehensive single treatment of the development, methodology, and systematic aspects of Economic Geography that, to this reviewer's knowledge, has ever appeared in geographical literature. As such, it merits close inspection.

The first two volumes, *Die Geographischen Grundlagen und Probleme des Wirtschaftslebens* (vol. 1, 1950) and *Die Produktionsraeume der Weltwirtschaft* (vol. 2, 1952), are from Luetgens' pen. In the first volume, which is essentially a revised enlargement of his previous *Allgemeine Wirtschaftsgeographie*, the author sets down his concepts of Economic Geography and lays the foundation for the subsequent

[1] C. Troll, "Die geographische Wissenschaft in Deutschland in den Jahren 1933 bis 1945," *Erdkunde*, Vol. I (1947), pp. 3–48.

[2] Vol. 1: Rudolf Luetgens. *Die Geographischen Grundlagen und Probleme des Wirtschaftslebens.* Stuttgart: Franckh'sche Verlagshandlung, 1950. 270 pp. 6½ x 9½. Maps, graphs, tables, bibliography, author index. DM 24.

Vol. 2: Rudolf Luetgens. *Die Produktionsraeume der Weltwirtschaft.* Stuttgart: Franckh'sche Verlagshandlung, 1952. 255 pp. 6½ x 9½. Maps, graphs, tables, bibliography, subject index. DM 28.

Vol. 3: Erich Otremba. *Allgemeine Agrar- und Industriegeographie.* Stuttgart: Franckh'sche Verlagshandlung, 1953. 342 pp. 6½ x 9½. Maps, graphs, photographs, tables, bibliography, author-and-subject index. DM 36.

Vol. 4: Erich Otremba. *Allgemeine Geographie des Welthandels und des Weltverkehrs.* Stuttgart: Franckh'sche Verlagshandlung, 1957. 380 pp. 6½ x 9½. Maps, graphs, photographs, tables, bibliography, author-and-subject index. DM 42.

Vol. 5: Edwin Fels. *Der Wirtschaftende Mensch als Gestalter der Erde.* Stuttgart: Franckh'sche Verlagshandlung, 1954. 258 pp. 6½ x 9½. Maps, graphs, tables, bibliography, subject index, place index. DM 30.

contributions. Having rather sketchily outlined the development of the subject, he defines it as a study of the interaction between (a) "earth-space in its fulfillment" (the physical, biological—including man as a biological being—and spatial features of the earth's surface) and (b) economic man, with particular attention to explanation of the distribution of the pertinent consequences of such interaction.[3] Its ultimate scientific goal is the recognition of economic landscapes, and its most important practical objective is the maximizing of efficiency in man's use of nature for economic purposes. Thus a truly geographical concept, the landscape, is considered in its relations with an economy, and thereby is emphasized the position of Economic Geography within the total discipline of Geography. Luetgens then proceeds to demonstrate the bonds between Economic Geography and both Geography and Economics, to subdivide Economic Geography into General and Special Economic Geography, and finally to subdivide the subdivisions.

General Economic Geography, world-wide in scope and organized systematically, is conceived to be composed of: General Foundations (climate; the land surface, together with the associated soils and minerals; the water surface and its exploitable resources; flora; fauna), General Comparative Economic Geography, the Geography of Production, the Geography of Trade and Transportation, and the Geography of Consumption. Special Economic Geography, in turn, is resolved into two constituents—Comparative and Regional. All of this terminology is self-evident except for Comparative Economic Geography, which refers to the study of individual interassociations between any landscape type (climate, landforms, soils, flora, fauna, etc.) and components of its superimposed economy. In General Comparative Economic Geography, the approach is systematic; in Special Comparative Economic Geography, the approach is regional and presumably the resultant work more detailed. Luetgens' basic divisions of Economic Geography thus appear similar to the traditional systematic and regional approaches to the entire discipline of Geography.

The remainder of the book—indeed, with allowance for individuality and originality of author viewpoint, of the entire series—is largely an elaboration of the General Economic Geography portion of this concept. Thus, in this first volume, Luetgens discusses and cites examples of the "General Foundations" and of their association with economic man; the human being as a dynamic force in establishing his economies; the resultant economic landscapes. The second volume is an appraisal, systematically arranged, of certain types of natural areas and their associated economies. In it, Luetgens separates the world's land from the water, refines the separations on the basis of climate, and finally discusses the "earth-space" associations of each of the seventeen subdivisions. Besides climate, other "General Foundations" are considered in these appraisals, as are specific structures, developmental stages, and forms (agriculture, mining, etc.) of economies. Where deemed necessary, broad cultural influences are traced and their current significance is examined.

The five books represent the combined efforts not only of three men but also of two generations, with Otremba supplying the younger viewpoint. His forceful and incisive examination of Agricultural and Industrial (chiefly manufacturing but including mining) Geography (vol. 3, *Allgemeine Agrar- und Industriegeographie*, 1953), and the Geography of World Trade and Transportation (vol. 4, *Allgemeine Geographie des Welthandels und des Weltverkehrs*, 1957), represents, for this reviewer, the apogee of the series. Within the framework of reference established by Luetgens, he conceives of Economic Geography as basically a study of the economic–geographic harmony of the earth's surface—a twofold harmony involving (a) all of the world's people with respect to all of its space, and (b) the association of individual regions with each other. The study has its systematic and regional approaches, and each may be appraised historically, structurally, and functionally, and no appraisal is complete without all of these considerations. The historical development of basic ideas, principles, and methodology is also of paramount importance, and Otremba emphasizes this by outlining in appreciable detail the development of the basic concepts of each of the facets for which he is responsible, and by tracing the threads of continuity to writings in related disciplines as well as to those of geographers.

His ultimate purpose is the interpretation of the economic landscape, and towards that end he employs every relevant method and tool, including direct observation; use of photographs (including excellent aerial photographs), maps, sketches, diagrams; descriptive numerical interpretation (essentially, however, without use of the tools of contemporary statistical methodology), and predictive theories propounded by scholars in related natural and social disciplines. He is not interested so much in prediction, however, as in understanding the current orientation of man's economic features towards nature and towards each other. Thus, for example, he notes that most agriculture is necessarily dispersed over extensive areas and is noteworthily oriented towards the natural environment. The ideal farm is a somewhat sprawling plot of ground around a single-family farmstead. Manufacturing, in contrast, usually reaches its peak of efficiency when it is markedly centralized. Seemingly, therefore, these two productive industries which are so vital to mankind's existence and which are the major economic instruments in changing the face of the earth, have little in common. But they find their union in the city, which is not only the site for manufacturing plants, but also the market and supply center for agriculture. In sparsely settled, underdeveloped lands, this union is somewhat superficial, for the participants of subsistence economies are rather independent of city influence. With increases in population, group living becomes more important

[3] Point "a" thus includes man as a biological being, and "b" as a cultural being, with emphasis upon his economies. Fels, in his introduction to *Der Wirtschaftende Mensch als Gestalter der Erde* (vol. 5 of the series), provides a threefold elaboration of this definition: (a) the influence of "life-filled nature-space" upon economic man (or, in other words, the geographical conditioning of economies); (b) the causal distribution of economic features (presumably, the causes being human decisions in the light of point "a"); and (c) the counter-influence by economic man upon "life-filled nature-space" (the effect of economies upon Geography). Fels states further that Economic Geography in the United States is focused sharply upon point "b" and is in need of revision.

to the country folk, if only to conserve land, and they begin to cluster into rural villages. With increasing technology as well as population, the manifold functional interrelationships between city and country, indeed between national economy and international economy, assume prominence, especially in the form of trade and associated transportation. Wherever and in whatever form production, trade, and transportation are found, they represent components of the areal and functional harmony in nature–human economic associations—a harmony that is expressed in the landscape. The basic task of the economic geographer is to understand this harmony.

How this understanding may be acquired is suggested by Otremba's approach to his *Allgemeine Agrar- und Industriegeographie*. He first regretfully separates the two productive activities for analysis—regretfully, because in reality they are very much interlaced. Then, centering attention upon Agricultural Geography, he first considers the abstract idea of agricultural (especially natural) potentialities, areally expressed (*Agrarraum*); this is followed by attention to pertinent social and social–psychological traits of agricultural populations; next comes a consideration of field demarcation of settlement forms, and of the recognizable systems (ranging from transhumance to mixed farming) of agricultural production; this is followed by an appraisal of entire agricultural economies, considered by *raison d'être* and natural and cultural ties; finally comes an examination of agricultural landscapes that have been delimited by the foregoing criteria, using specific examples from Europe, North America, and Asia.

The same approach cannot be applied rigidly to Industrial Geography, wherein the chief instruments of production are not only concentrated into areal nodes, but usually are more nebulously oriented to natural conditions than is agriculture. The element of human decision and the economic land-use theories associated therewith assume an increased measure of importance in Industrial Geography. The natural environment is not to be overlooked, however, especially as a source of energy and raw materials. But the ultimate location of most industries, whether isolated or clustered, depends largely upon human judgment in the matter of production costs and market advantages, as these are revealed in the cultural and societal frame of reference within which the individual makes his decisions. In understanding the resultant location, Otremba maintains, economic geographers should be very sensitive to location theories. However, their main responsibility is not to develop such theories, but to understand the status quo. To accomplish this purpose, they should work from basic observation, from knowledge of the origin and historical development of the features under consideration, and from a familiarity with the present operation of any single industry or group of industries. In short, the approach is basically subjective and the methods mainly qualitative (although relevant quantification is encouraged), but within a framework of reference that is logical. Having derived this approach, the author proceeds to examine the nature of industrial areas, noting the influence thereon from natural endowment and from social structure and psychological attitude towards economic endeavor. Subsequently, he systematizes the world's major mining and manufacturing industries into three basic types: (a) handicraft and other home industries, (b) raw materials industries, and (c) finished products industries. This is followed by an examination of selected industrial landscapes. The book's final pages are an attempt to recombine agriculture and industry and to classify the results into ten categories ranging in complexity from primitive economies removed from the world scheme of things to technically advanced, industrial economies.

In his *Allgemeine Geographie des Welthandels und des Weltverkehrs* (vol. 4, 1957), Otremba assigns to trade and associated transportation the major responsibility for functional interaction among man's economies. His goal, as in the previous volume, is understanding existing and potential harmony among man, his economies, and nature. The ideal man–land association should result in the maximum use by man of each world region, and in unfettered exchange of truly surplus commodities among the regions. That human beings are in want today in many sections of the world is due not so much to a breakdown in production as to inefficient distribution of goods which have been or could be produced. The Geography of Trade thus assumes a vital ethical, as well as economic, importance. Trade and transportation are inextricably associated and cannot be satisfactorily divided, even for analysis. Thus, the author's approach in this book differs from that in his earlier volume chiefly in that the two subjects under consideration are treated as a compound rather than as single branches. Where actively carried on, trade is the method and transportation the means of satisfying economic needs and wants of human beings. Ideally, surplus supplies would go to areas of demand—or, even more ideally, of need. Actually, however, the technically advanced societies exercise control over trade and transportation routes.

The book is in three parts. (1) The first part is a general evaluation of the geographical foundations and concepts of trade and transportation. Herein Otremba reviews the origin and growth of both subjects, notes the major contributions to each by geographers and others, and examines the methodology which, particularly for trade, he finds scanty. He summarizes the historical development of trade and transportation and emphasizes the increased importance of each as economies become more sophisticated and specialized. Conceiving of transportation as the movement of people (and, to a degree, of information) as well as goods, he sketches the significance of the grand emigration from Europe during and after the Age of Discovery, and of current movement by migratory and commuter laborers, by recreationists, by religious commuters and pilgrims, and by general travelers. But most transportation results from the need to carry commodities, and these vary as to supply and demand among the various types of world economies. (2) In the second part, he analyzes the components of trade and transportation as viewed in their dependence upon geographical and economic features. He writes of the route, the market, and the traffic—all areally expressed—as the fundamental qualities of trade and transportation of interest to economic geographers. (3) In the third part, he turns attention to economic areas of the world, with special attention to their interdependence and their association with the

geographical structure of trade and transportation. He weighs the significance of certain areas, natural and cultural, to trade and transportation, with particular emphasis upon political units considered as to location and economic structure. Classifying the world's economies by degree of dependence upon world markets, he discusses the pertinent trade and transportation features of each. Broadening the focus, he considers trade and transportation as applied to wide economic areas, delimited first by maritime or continental orientation, and secondly by type of economy. Finally, he gives attention to the general concept of spatial accessibility to trade and transportation, deriving three stages of intensity: (a) that of areas currently without accessibility, (b) that of areas (such as resorts) where transportation involves primarily the movement of people rather than goods, and (c) that of areas where movement of goods is predominant.

Edwin Fels, in the final work of the series, inquires into the role of economic man in altering his natural environment, and thereby appraises the remainder of Luetgens' man-"earth-space" cycle. This study, a revision of Fels' *Der Mensch als Gestalter der Erde*, involves more concentration upon man's economic instruments than was true of his earlier book. His major outline involves man's effect upon: (a) the lithosphere (where he has constructed settlements and transportation features, has dug open-pit and shaft-and-tunnel mines, has altered coastlines, reclaimed and reworked land, and removed forests); (b) the earth's water system (where he has altered water tables, drained swamps, regulated and altered waterways and water bodies); (c) its climate (where his interests have ranged from forecasting to creating, in limited areas, artificial climates); flora; and fauna. Finally, man himself has changed as a part of the over-all transfiguration of the "life-filled earth-space" —has changed especially in number and distribution of population and in the mixing of racial types. These changes, too, have affected the economic landscape.

We economic geographers should be grateful for the series, particularly for its fundamental contribution of gathering together a number of loose ends into a single treatment. On the whole, it espouses no dramatically new theories, but provides a well-done framework of reference for future work. It is in places repetitious, and in places it appears to belabor the obvious, but such characteristics would almost necessarily accompany a complex contribution by three leading scholars. Some of its implications and conclusions will not be universally accepted. For example, not all economic geographers will agree with the premise that Economic Geography is essentially a landscape study—a kind of intellectual thumbing of a mail-order catalogue. Nor will all agree that economic geographers should stifle the urge to develop theories. However, the series does represent a concerted and certainly widely accepted viewpoint which now ought to be extensively applied. Otremba states in the preface to his second volume that what is currently lacking in Economic Geography is a comprehensive study of the world's economic regions or landscapes—a suggestion to which geographers of other nations, including the United States, might give serious attention.

Although by far the most significant, the *Erde und Weltwirtschaft* series has not been the only contribution in the past decade to methodological discussion in Germany. Some of Hettner's concepts concerning Transportation Geography have been published posthumously in a book entitled *Verkehrsgeographie*, the third volume of his *Allgemeine Geographie des Menschen*, which is being published gradually by his former colleagues and students.[4] With his pronounced orientation towards regional investigation as the prime responsibility in geographic effort, Hettner conceives of transportation as the bonds within and among regions, extending ultimately throughout the world. The subject involves the movement of men, goods, and information—and thus is actually a consideration of communication as well as transportation. Where meritorious of serious study, this movement is at least quasi-regular, and hence the unilinear migrations of men, such as the European emigration over the past five centuries, are not to be given lengthy consideration. Within this framework, Hettner describes the various transportation and communication media of land, sea, and air, discusses their historical development and their association with the natural environment, and notes their regional and world distribution and significance.

Among the journal discussants, whether applying current techniques of German Economic Geography or giving special attention to methodology, Theodor Kraus has made two laudable contributions which maintain that economic geographers should take full advantage of existing economic theories—notably of von Thuenen, Weber, Christaller, Waibel, Englaender, Predoehl, Weigmann, Palander, and Loesch — in regional investigations.[5]

How have these publications affected German Economic Geography? It would appear that their primary effect has been the emphasis upon Economic Geography as a distinct study with a definite responsibility. The subdiscipline never has been neatly isolated from the over-all field of Geography, even for analysis, and there appears little possibility that it will be; for, unlike some of the more highly specialized branches, Economic Geography permeates the entire field. A thorough study of the Economic Geography of an area would leave little untouched that would be considered in an equally thorough study of the Geography of that area. By holding rigidly to interpretation of the economic landscape as the primary task of economic geographers, our German colleagues have set down a conceptual framework that should be of some consolation when a scholar attempts the ever-difficult task of selecting criteria with which to delimit and evaluate a region. There also is discernible another and highly significant contribution in these studies: the relaxing of excessive attention to nature in an evaluation of man–land economic associations and the concomitant increase in awareness of the value of scholarly work from other disciplines, especially economics, to our own efforts. This resembles an analogous trend in the United States. It is to

[4] Alfred Hettner. *Allgemeine Geographie des Menschen*. Vol. 3: *Verkehrsgeographie*. Heinrich Schmitthenner, ed.; Stuttgart: W. Kohlhammer, 1952. 201 pp. 6½ x 9½. Table of contents only. DM 15.

[5] Theodor Kraus. "Raeumliche Ordnung als Ergebnis geistiger Kraefte," *Erdkunde*, Vol. II (1948), pp. 151–55; "Wirtschaftsgeographie als Geographie und als Wirtschaftswissenschaft," *Die Erde*, Vol. VIII, No. 2 (1957), pp. 110–119.

be hoped, however, that the Hegelian pendulum does not swing completely from appreciation of the natural environment; and, at least in German literature, it does not appear to be doing so.

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